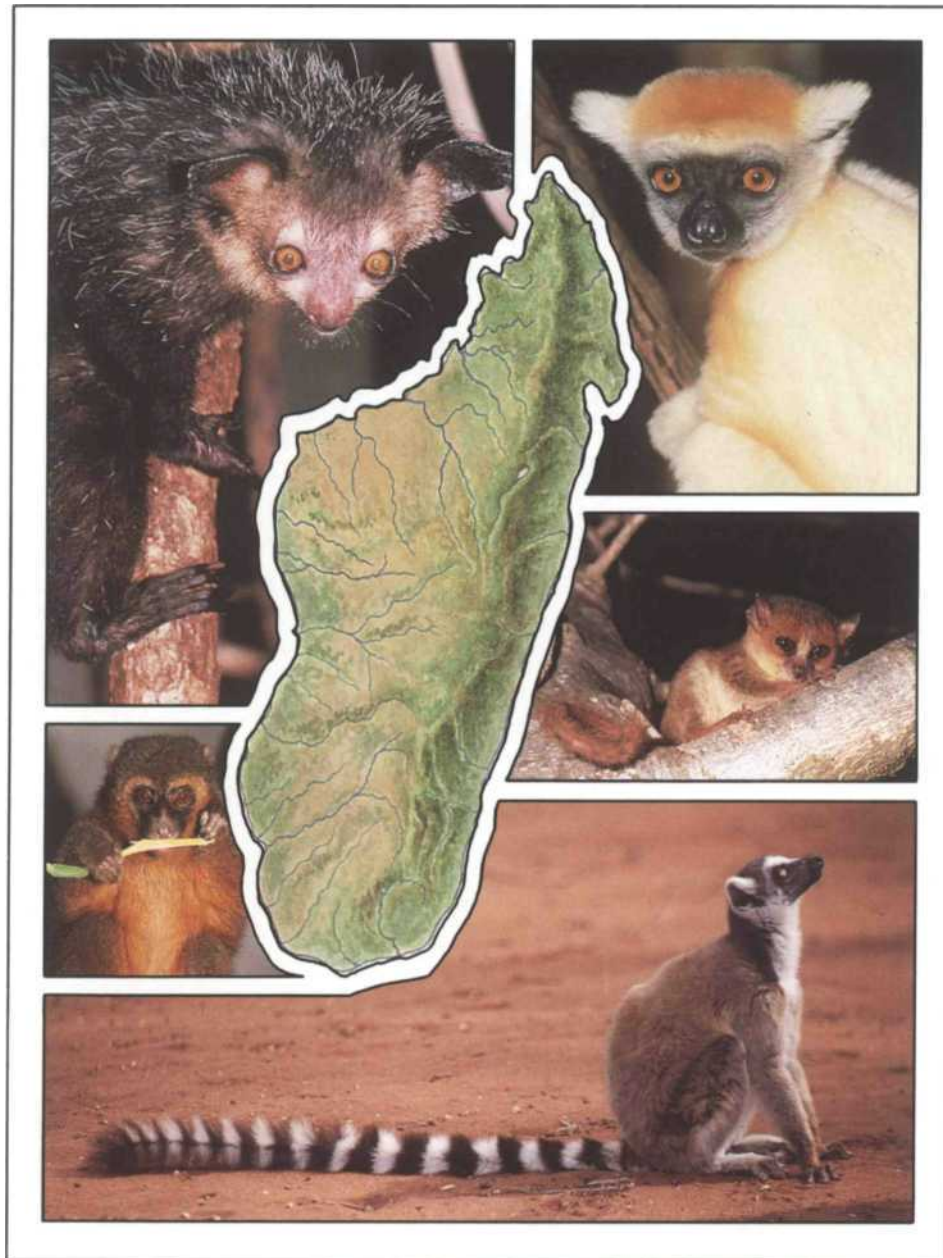


Lemurs of Madagascar

An Action Plan for their Conservation 1993-1999



Compiled by
Russell A. Mittermeier, William R. Konstant,
Martin E. Nicoll and Olivier Langrand
IUCN/SSC Primate Specialist Group



IUCN Species Survival Commission: A Global Network for Species Survival

Habitats and their living natural resources are under increasing pressures everywhere from humankind. Species, the basic biotic units, are consequently increasingly threatened with extinction. To protect and conserve biodiversity from species level to ecosystems requires management based on understanding of not just biological sciences, but also knowledge of local cultures, environmental economics and governmental structures and dynamics.

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Each taxonomic group is charged to assess the conservation status of the chosen species and their habitats, to develop an Action Plan that specifies conservation priorities and finally to promote the implementation of required activities outlined in the Plan. Developing an Action Plan may take several months or years; full implementation of an action agenda may span several decades. Action Plans have been completed by 17 Specialist Groups.

Besides developing general conservation policy, such as the World Conservation Strategy, IUCN manages conservation projects worldwide, including projects on tropical forests, wetlands, marine ecosystems, the Sahel, Antarctica and sustainable development.

For more information on the Species Survival Commission and IUCN-The World Conservation Union, contact IUCN, Avenue du Mont-Blanc, CH-1196 Gland, Switzerland. Telephone (22) 364 9114; Telefax (22) 364 2926.

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Upper Right - Tattersall's sifaka *Propithecus tattersalli* (David Haring)
Middle Left - Golden bamboo lemur *Haplemur aureus* (Russell A. Mittermeier)
Middle Right - Gray mouse lemur *Microcebus murinus* (Russell A. Mittermeier)
Bottom - Ring-tailed lemur *Lemur catta* (William R. Konstant)
Map of Madagascar by Stephen Nash

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Contents

Foreword	iii
Acknowledgements	iv
Section 1: Introduction	1
Taxonomy of Madagascar Lemurs	1
Priority Rating of Lemur Taxa for Conservation Action	3
Section 2: Biogeographic Regions of Madagascar	5
Section 3: Protected Areas of Madagascar and Other Areas of Biological Importance	7
Protected Areas	10
Eastern Region	10
Western Region	14
Unprotected Areas of Biological Importance	16
Eastern Region	16
Western Region	17
Section 4: Lemur Taxa of Conservation Concern	18
Highest Priority	18
High Priority	28
Priority	35
Section 5: Conservation Priorities for Madagascar Lemurs	39
Recommendations by Region, Protected Areas and Lemur Communities	41
Eastern Region	41
Western Region	45
Public Awareness Campaigns	48
Genetic Research	50
Professional Training	50
Captive Breeding	50
Section 6: Lemur Action Plan Budget (1993-1999)	51
References	55

Foreword

Madagascar is without a doubt one of the world's highest primate conservation priorities, with very high levels of primate diversity and endemism and more endangered and vulnerable primate taxa than any other country. Madagascar is fourth on the world list of primate species (in spite of being only 1/7 the size of Brazil, the world leader, and roughly one-quarter the size of Indonesia or Zaire, second and third on the world list). Its level of primate endemism, 28 of 30 species (93.5%) or 48 of 50 taxa (96%), is by far the highest in the world. Even the two species that occur elsewhere are found only on the nearby Comores where they were probably introduced from Madagascar.

At the generic and family levels, Madagascar's diversity is even more striking, with fully five primate families, four of which are endemic, and 14 genera of which 13 are found nowhere else. Compare this to Brazil, which has only three families, none of them endemic, and only two endemic genera out of 16. Of the 50 lemur taxa currently recognized for Madagascar, fully 12 are considered endangered and another 18 are believed to be of conservation concern, figures matched only by Brazil. Furthermore, one entire family (Daubentonidae) and five genera are considered endangered, a degree of endangerment at higher taxonomic levels that not even Brazil can match and that is of great international concern.

Looking at Madagascar's diversity in yet another way, Madagascar alone is home to 13% (30/236) of all primate species and 25% (14/57) of all primate genera, a great responsibility for any one nation.

Madagascar also demonstrates clearly that primate extinctions are a very real phenomenon and not a figment of the conservationist's imagination. Fully six genera and at least 14 species of lemurs have already gone extinct on this island since the arrival of our own species there less than 2000 years ago, and, as indicated here, many others could disappear within the next few decades if rapid action is not taken.

The Primate Specialist Group of IUCN/SSC has long recognized Madagascar as a top priority and is pleased to present this Action Plan to guide its activities over the critical last decade of the 20th century. As should be obvious from the projects described here, one of the most glaring gaps in our knowledge of lemurs is often the most basic information on

geographic distribution and conservation status. In spite of several centuries of observation and collection and more than three decades of research, we still are not clear as to the limits of distribution of most species and have only the most subjective impressions of conservation status for many taxa.

The striking cases of two new species being discovered in the last five years, another being rediscovered, and yet another, the aye-aye, previously believed to be highly restricted and nearly extinct and now being found in many different parts of the island, are good indicators of how ignorant we still are. Clearly, much more thorough survey work is needed for all species, with special emphasis on the most endangered, among them *Hapalemur aureus*, *Hapalemur simus*, *Hapalemur griseus alaotrensis*, *Varecia variegata variegata*, *Varecia variegata rubra*, *Propithecus diadema diadema*, *Propithecus diademaperrieri*, *Propithecus tattersalli*, *Indri indri*, *Daubentonia madagascariensis* and *Allocebus trichotis*. Projects for all of these and many other species are included in the Action Plan.

Another key feature of the Action Plan is a wide variety of projects using these beautiful and unique species as "flagships" for public awareness and education campaigns, both to stimulate general interest in conservation within Madagascar and to focus ever more international attention on the importance of this country in global efforts to conserve biological diversity. Since lemurs are the most attractive, conspicuous and best known of Madagascar's wildlife, they are ideally suited to this purpose.

Along with this Action Plan, we are also publishing a field guide to the lemurs of Madagascar to stimulate ecotourism and basic research. As with other publications of their kind, these documents have been collaborative efforts incorporating the knowledge of a number of specialists both in Madagascar and internationally. We believe that they come at a timely moment in the history of Madagascar and that they will serve to stimulate interest in and facilitate conservation efforts for these wonderful creatures and their remaining habitat.

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Implementation of the Action Plan will be carried out by the following Malagasy agencies, institutions and ministries in collaboration with a variety of international partners: the National Environment Office (ONE), the National Association for the Management of Protected Areas (ANGAP), the Ministry of Water and Forests (MPAEF), the Ministry of Universities, the Ministry of Scientific Research and the Ministry of Foreign Affairs.

The compilers take full responsibility for the content of this Action Plan. Anyone interested in helping to support its implementation can contact them at the following addresses:

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Section 1: Introduction

The family-level classification of Madagascar primate genera into five families follows the recommendations of Schwartz and Tattersall (1985), but we recognize the new genus *Eulemur* as representing all members of genus *Lemur* other than *Lemur catta*, according to Simons and Rumpler (1988). Species and subspecies-level taxonomy is based on Tattersall (1982) with the exception that the arrangement of *Lepilemur* follows Petter *et al.* (1977) in recognizing seven species. However, since the appearance of Tattersall's book (1982), the taxonomy has been modified to reflect subsequently described species and taxonomic revisions. The two new species of lemurs mentioned above, *Hapalemur aureus* (Meier *et al.*, 1987) and *Propithecus tattersalli* (Simons, 1988), have appeared since Tattersall's (1982) book. Other changes include the rediscovery of *Eulemur macaco flavifrons* (Koenders *et al.*, 1985), *Propithecus diadema holomelas* placed in synonymy of *P. d. edwardsi* (Tattersall, 1986) and partition of *Phaner furcifer* into four subspecies (Groves and Tattersall, 1991). We do not consider the information in Tattersall (1988) sufficient to lump *Propithecus verreauxi coronatus* into synonymy with *P. v. deckeni* given the contradictory information reported in Harcourt and Thornback (1990) and our own observations.

Several taxonomic questions merit further study, including whether or not *Propithecus diadema holomelas* and *P. d. edwardsi* are synonymous, whether *P. verreauxi deckeni* and *P. v. coronatus* are synonymous, whether currently recognized *Varecia variegata variegata* (fide Tattersall, 1982) consists of two or three distinct subspecies and whether there exist undescribed subspecies of *Eulemur rubriventer* and *Microcebus rufus* (Tattersall, 1982).

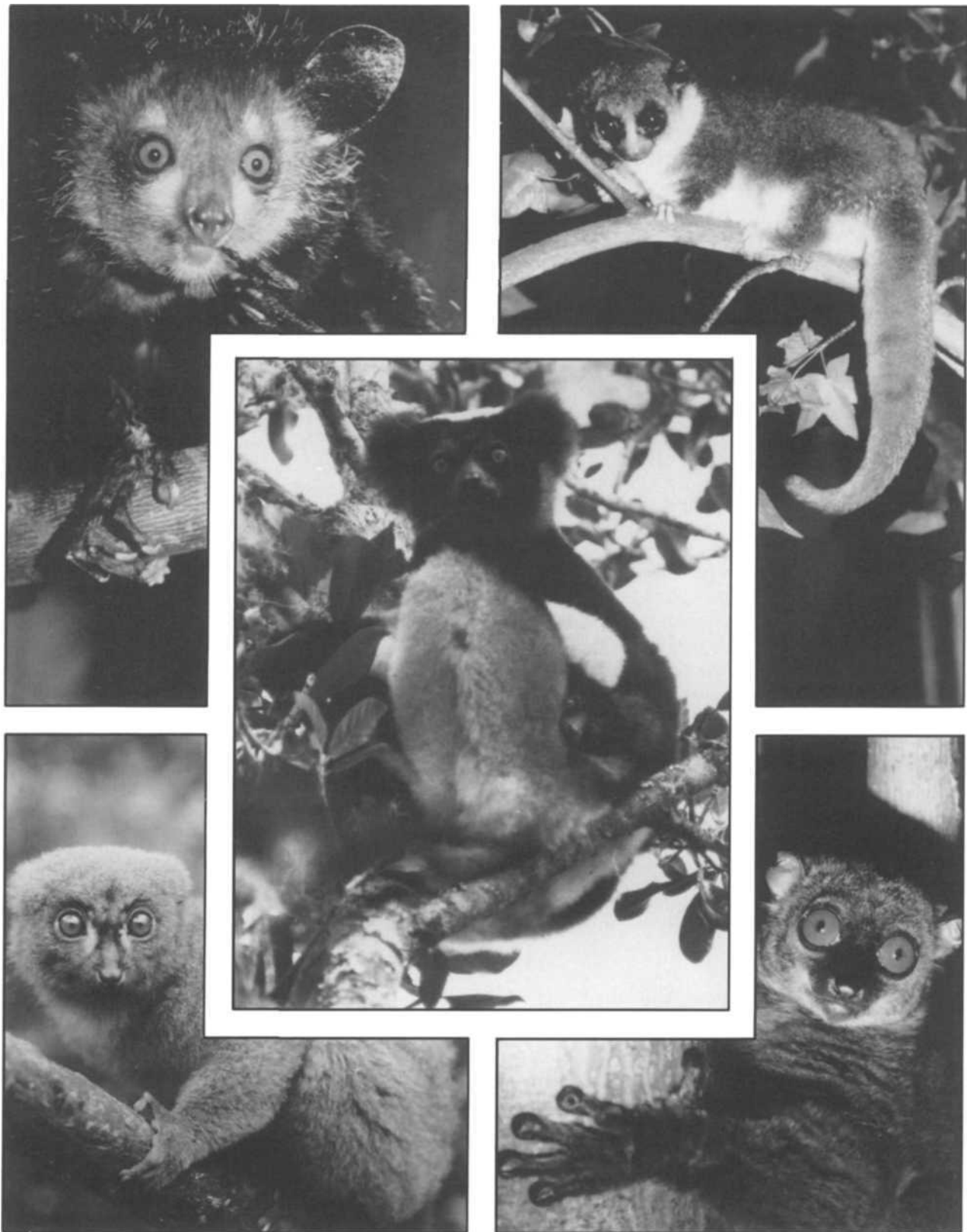
Based on available information, the following list of taxa has been assembled.

Table 1
Taxonomy of Madagascar Lemurs

Scientific Name	Common Name
Family Daubentonidae	
<i>Daubentonia madagascariensis</i>	Aye-aye
Family Cheirogaleidae	
<i>Microcebus murinus</i>	Gray mouse lemur
<i>Microcebus rufus</i>	Brown mouse lemur
<i>Mirza coquereli</i>	Coquerel's dwarf lemur
<i>Cheirogaleus medius</i>	Fat-tailed dwarf lemur
<i>Cheirogaleus major</i>	Greater dwarf lemur
<i>Allocebus trichotis</i>	Hairy-eared dwarf lemur
<i>Phaner f. furcifer</i>	Fork-marked dwarf lemur
<i>P. f. electromontis</i>	
<i>P. f. pallescens</i>	
<i>P. f. parienti</i>	

Scientific Name	Common Name
Family Megaladapidae	
<i>Lepilemur dorsalis</i>	Nosy Be sportive lemur
<i>Lepilemur edwardsi</i>	Milne-Edward's sportive lemur
<i>Lepilemur leucopus</i>	White-footed sportive lemur
<i>Lepilemur microdon</i>	Microdon sportive lemur
<i>Lepilemur mustelinus</i>	Weasel sportive lemur
<i>Lepilemur ruficaudatus</i>	Red-tailed sportive lemur
<i>Lepilemur septentrionalis</i>	Northern sportive lemur
Family Lemuridae	
<i>Lemur catta</i>	Ring-tailed lemur
<i>Eulemur coronatus</i>	Crowned lemur
<i>Eulemur macaco macaco</i>	Black lemur
<i>E. m. flavifrons</i>	Sclater's lemur
<i>Eulemur mongoz</i>	Mongoose lemur
<i>Eulemur rubriventer</i>	Red-bellied lemur
<i>Eulemur f. fulvus</i>	Brown lemur
<i>E. f. albifrons</i>	White-fronted brown lemur
<i>E. f. albocollaris</i>	White-collared brown lemur
<i>E. f. collaris</i>	Collared brown lemur
<i>E. f. mayottensis</i>	Mayotte brown lemur
<i>E. f. rufus</i>	Red-fronted brown lemur
<i>E. f. sanfordi</i>	Sanford's brown lemur
<i>Varecia variegata variegata</i>	Black-and-white ruffed lemur
<i>V. v. rubra</i>	Red ruffed lemur
<i>Hapalemur g. griseus</i>	Eastern lesser bamboo lemur; Gray gentle lemur
<i>H. g. alaotrensis</i>	Lac Alaotra lesser bamboo lemur; Lac Alaotra gentle lemur
<i>H. g. occidentalis</i>	Western lesser bamboo lemur; Western gentle lemur
<i>Hapalemur aureus</i>	Golden bamboo lemur
<i>Hapalemur simus</i>	Greater bamboo lemur; Broad-nosed gentle lemur

Family Indriidae	
<i>Avahi l. laniger</i>	Eastern avahi; Eastern woolly lemur
<i>A. l. occidentalis</i>	Western avahi; Western woolly lemur
<i>Indri indri</i>	Indri
<i>Propithecus d. diadema</i>	Simpona; diademed sifaka
<i>P. d. edwardsi</i>	Simpona; Milne-Edward's sifaka
<i>P. d. candidus</i>	Silky sifaka
<i>P. d. perrieri</i>	Perrier's sifaka
<i>Propithecus tattersalli</i>	Tattersall's sifaka
<i>Propithecus v. verreauxi</i>	Verreaux's sifaka
<i>P. v. coquereli</i>	Coquerel's sifaka
<i>P. v. coronatus</i>	Crowned sifaka
<i>P. v. deckeni</i>	Decken's sifaka



Five Families of Madagascar Lemurs

Upper left: Daubentonidae - Aye-aye *Daubentonia madagascariensis* (David Haring)

Upper right: Cheirogaleidae - Fat-tailed dwarf lemur *Cheirogaleus medius* (David Haring)

Lower left: Lemuridae - Red-bellied lemur *Eulemur rubriventer* (Russell A. Mittermeier)

Lower right: Megaladapidae - Nosy Be sportive lemur *Lepilemur dorsalis* (Russell A. Mittermeier)

Center: Indriidae - Indri *Indri indri* (Russell A. Mittermeier)

Priority Ratings of Lemur for Conservation Action

In recognizing levels of threat to existing lemur populations and in assigning priority ratings for conservation action, this document revises criteria used in the Action Plans for African and Asian Primate Conservation (Oates, 1986; Eudey, 1987). Degree of Threat is viewed in terms of total population size, estimated to the nearest order of magnitude, and considers that lemur habitats throughout Madagascar are severely and equally threatened. A single adjustment has been made for taxonomic uniqueness; the highest priority is now set at Category 4 for species representing the only member of a monotypic family. This recognizes the unique taxonomic position of the aye-aye (*Daubentonia madagascariensis*) among Madagascar's lemurs and among the world's primates as a whole, as the only endangered monotypic nonhuman primate family. Also, in contrast to the two earlier primate action plans, associations with other threatened taxa are not used to rate the various taxa, but as a tool for assigning priorities to recommended conservation actions that are presented later in this document. Finally, slightly higher priority is given to those taxa not found in any officially protected areas.

The decision was made to use only rough estimates of total population sizes to assign degree of threat, rather than implement a classification proposed recently by Mace and Lande (1991). According to their re-evaluation of IUCN threatened species categories, taxa are classified as either critical, endangered, vulnerable or not at risk, this based upon numerical estimates of total and effective populations sizes, numbers and sizes of subpopulations, rates of population decline and the possible effects of catastrophic events. Although the Mace/Lande system may become the accepted format for future action plans, the compilers of this document feel that available information

about Madagascar lemur numbers and population trends is not yet sufficient to warrant its use at this time.

Priority ratings for conservation action have been assigned to species and subspecies of Madagascar lemurs based on the following criteria:

Biological

Degree of Threat

1. Total population *probably* greater than 100,000.
2. Total population *probably* between 10,000 and 100,000.
3. Total population *probably* between 1,000 and 10,000.
4. Total population *probably* between 100 and 1,000.
5. Total population *probably* less than 100.

Taxonomic Uniqueness

1. A member of a large species group (i.e., one of several closely related species), or species status is sometimes questioned, but is at least a distinct subspecies.
2. A very distinct monotypic species, or one of a small number of closely related forms that together are clearly distinct from other species.
3. Only member of a monotypic genus.
4. Only member of a monotypic family.

Political

Level of Protection

One point is added to the priority rating if the taxon in question is not known to occur in any protected area.

Table 2
Conservation Priority Ratings for Lemurs

Species	Biological		Political		Species	Biological		Political	
	Degree of Threat	Taxonomic Uniqueness	Level of Protection	Total Rating		Degree of Threat	Taxonomic Uniqueness	Level of Protection	Total Rating
Daubentonidae					Lemuridae (continued)				
<i>Daubentonia madagascariensis</i>	3	4		7	<i>Eulemur f. fulvus</i>	1	1		2
Cheirogaleidae					<i>E. f. albifrons</i>	1	1		2
<i>Microcebus murinus</i>	1	2		3	<i>E. f. albocollaris</i>	3	1		4
<i>Microcebus rufus</i>	1	2		3	<i>E. f. collaris</i>	2	1		3
<i>Mirza coquereli</i>	2	3		5	<i>E. f. mayottensis</i>	2	1	1	4
<i>Cheirogaleus medius</i>	1	2		3	<i>E. f. rufus</i>	1	1		2
<i>Cheirogaleus major</i>	1	2		3	<i>E. f. sanfordi</i>	2	1		3
<i>Allocebus trichotis</i>	4	3		7	<i>Varecia variegata variegata</i>	3	2		5
<i>Phaner f. furcifer</i>	3	1		5	<i>V. variegata rubra</i>	3	2	1	6
<i>P. f. electromontis</i>	3	2		5	<i>Hapalemur g. griseus</i>	1	2		3
<i>P. f. pallescens</i>	3	2		5	<i>H. g. alaotrensis</i>	4	2	1	7
<i>P. f. parienti</i>	3	2		5	<i>H. g. occidentalis</i>	2	2		4
Megaladapidae					<i>Hapalemur aureus</i>	4	2		6
<i>Lepilemur dorsalis</i>	2	1		3	<i>Hapalemur simus</i>	4	2		6
<i>Lepilemur edwardsi</i>	1	1		2	Indriidae				
<i>Lepilemur leucopus</i>	1	1		2	<i>Avahi l. laniger</i>	2	2		4
<i>Lepilemur microdon</i>	2	1		3	<i>A. l. occidentalis</i>	2	2		4
<i>Lepilemur mustelinus</i>	2	1		3	<i>Indri indri</i>	3	3		6
<i>Lepilemur ruficaudatus</i>	2	1		3	<i>Propithecus d. diadema</i>	3	2		5
<i>Lepilemur septentrionalis</i>	2	1		3	<i>P. d. edwardsi</i>	3	2		5
Lemuridae					<i>P. d. candidus</i>	4	2		6
<i>Lemur catta</i>	2	3		5	<i>P. d. perrieri</i>	4	2		6
<i>Eulemur coronatus</i>	3	1		4	<i>Propithecus tattersalli</i>	3	2	1	6
<i>Eulemur m. macaco</i>	2	1		3	<i>Propithecus variegata verreauxi</i>	1	2		3
<i>E. m. flavifrons</i>	4	1	1	6	<i>P. v. coquereli</i>	3	2		5
<i>Eulemur mongoz</i>	3	1		4	<i>P. v. coronatus</i>	4	2	1	7
<i>Eulemur rubriventer</i>	2	1		1	<i>P. v. deckeni</i>	3	2		5

Table 3
Major Lemur Conservation Priorities by Taxa

Highest Priority (6-7)	High Priority (5)	Priority (4)
<i>Daubentonia madagascariensis</i>	<i>Mirza coquereli</i>	<i>Eulemur coronatus</i>
<i>Allocebus trichotis</i>	<i>Phaner f. furcifer</i>	<i>Eulemur mongoz</i>
<i>Eulemur macaco flavifrons</i>	<i>Phaner f. electromontis</i>	<i>Eulemur fulvus albocollaris</i>
<i>Varecia variegata rubra</i>	<i>Phaner f. pallescens</i>	<i>Eulemur f. mayottensis</i>
<i>Hapalemur aureus</i>	<i>Phaner f. parienti</i>	<i>Hapalemur griseus occidentalis</i>
<i>Hapalemur simus</i>	<i>Lemur catta</i>	<i>Avahi l. laniger</i>
<i>Hapalemur griseus alaotrensis</i>	<i>Varecia variegata variegata</i>	<i>Avahi laniger occidentalis</i>
<i>Indri indri</i>	<i>Propithecus d. diadema</i>	
<i>Propithecus diadema candidus</i>	<i>Propithecus d. edwardsi</i>	
<i>Propithecus diadema perrieri</i>	<i>Propithecus verreauxi</i>	
<i>Propithecus tattersalli</i>	<i>coquereli</i>	
<i>Propithecus verreauxi coronatus</i>	<i>Propithecus verreauxi deckeni</i>	

Section 2: Biogeographic Regions of Madagascar

According to White (1983) in *The Vegetation of Africa*, Madagascar can be divided into two major biogeographic regions — Eastern and Western (Fig. 1). The Eastern Region comprises four floristic domains: Eastern, Central, High Mountain and Sambirano. The Western Region is divided into two Domains: Western and Southern. Each Domain is characterized by specific types of vegetation. In this Action Plan, we have used descriptions of the different regions as provided in Langrand (1990) and Nicoll and Rathbun (1990).

Eastern Region

Eastern Domain

Lowland rainforest, the natural vegetation between sea level and 800 m altitude, extends along the east coast from north of Samabava to Tolagnaro. The average annual precipitation is between 2,000-3,000 mm and there is no dry season. Height of the evergreen canopy averages between 20-30 m, with no emergent trees. This region is characterized by high species diversity and endemism. Eastern lowland forest represents one of the most endangered vegetation types in Madagascar (only the less extensive Sambirano and High Mountain Domains are more at risk), most of it having already been cleared. The largest remaining tracts are found in the northeastern and southeastern parts of the country.

Central Domain

Forests of the Central Domain parallel those of the Eastern Domain and extend westward to Madagascar's central plateau above the 800 m elevation to altitudes of 1,300 m and occasionally reach 2,000 m. Average annual rainfall exceeds 1,500 mm and there is no dry season. Species diversity is as high as in the Eastern Domain; the level of endemism, however, is higher. The forest canopy is lower, averaging between 20-25 m; the epiphytic vegetation is more plentiful and the herbaceous stratum more developed. Most rainforest has disappeared in the Central Domain, but it remains Madagascar's most extensive biogeographic formation. The chief threats to this region are slash-and-burn cultivation, *tavy*, and exploitation for firewood.

High Mountain Domain

This domain comprises five distinct components: Tsaratanana in the northwest, Marojejy in the northeast, Ankaratra in the central east, Andringitra in the central southeast and Andohahela in the southeast. Forests of the High Mountain Domain grow at altitudes of 2,000-2,867 m. Rainfall is substantial throughout the year and there is a marked diurnal and seasonal variation in temperature. Species diversity is lower here than in previously mentioned domains, but species endemism is high. Fire is the chief threat to this vegetation type. The two largest intact blocks remaining are those at Marojejy and Andohahela.

Sambirano Domain

This domain consists of a small enclave of seasonal moist forest in the northwest. Together with the Tsaratanana Massif, it constitutes the northern end of the island's central mountain range. Annual rainfall exceeds 2,000 mm. The Sambirano is characterized by high species diversity and a high level of endemism, and it represents something of a transition zone between Madagascar's Eastern and Western Regions. Forest canopy height is about 30 m, with some emergents. The chief threats to this vegetation type is cultivation of rice and coffee.

Western Region

Western Domain

The vegetation of the Western Domain now consists of discontinuous patches of deciduous dry forests on the coastal plains and limestone plateaus, ranging from sea level to 800 m. It covers the area from Antsiranana in the north to Morombe in the southwest. Annual rainfall ranges from 500-2,000 mm, being lightest in the south and heaviest in the north. There is a marked dry season of almost seven months during which many trees of the canopy layer shed their leaves. The shrub layer is well developed and vines are common. Plant species diversity is lower than forests of the Eastern Region (while lemur species diversity is similar), but the level of endemism is higher. The principal threats to this type of vegetation are slash-and-burn cultivation, fire and uncontrolled use by livestock.

Southern Domain

The Southern Domain is characterized by deciduous thicket or thorn scrub, and is perhaps the least disturbed of Madagascar's biogeographic areas. It runs southward from Morombe along the coast, covering much of Madagascar's southern tip from sea level to 400 m. Rainfall in this region is sparse and irregular, ranging from 300-800 mm. The dry season is marked and very long. Forest height is low and the formations are usually impenetrable due to a high incidence of thorny vegetation. The Didiereaceae, an endemic plant family, and various species of *Euphorbia* are the dominant plant forms. Species diversity and the level of endemism are high.

The primary threats to forests of the Southern Domain are the collection of firewood and of ornamental and medicinal plants, charcoal production and the uncontrolled use of the land for livestock, especially cattle and goats. Slash-and-burn agriculture is not a significant threat due to the poor quality of the soils.

The compilers of this Action Plan recognize the fact that the conservation status of the various species and subspecies of lemurs is related to the conservation status of the different biogeographical regions and the habitats within them. For this reason, we will present information about species, protected areas and proposed actions according to forest types within Madagascar's biogeographical regions.

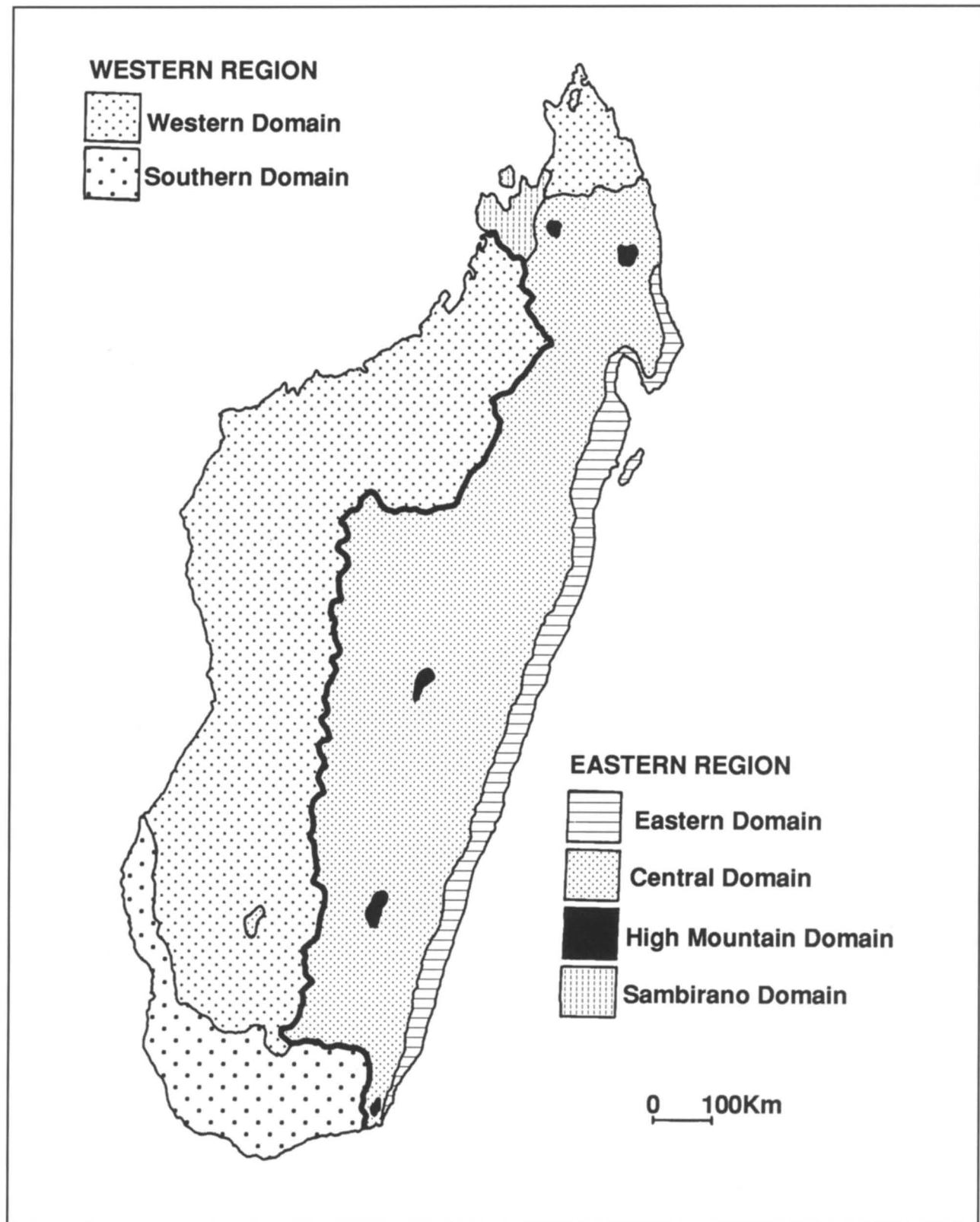


Figure 1. Biogeographic regions of Madagascar.

Section 3: Protected Areas of Madagascar and Other Areas of Biological Importance

The basic system of protected areas in Madagascar was established in 1927. It includes National Parks, Strict Nature Reserves, Special Reserves and Private Reserves (Figs. 2,3). Reserves have been managed traditionally by Madagascar's Ministry of Water and Forests (of the Water and Forestry Department), with assistance from the Ministry of Universities (formerly the Ministry of Higher Education) in several cases. In December 1990, a National Association for the Management of Protected Areas (ANGAP) was created to coordinate management of protected areas with the Government of Madagascar and national and foreign operators (Greve, 1991). Approximately 2% of Madagascar's land area is included in the protected area system.

National Parks (*Parcs Nationaux*)

Legislation establishing National Parks was passed in 1958 and 1962. Madagascar's National Parks are open to visitation by the public but access is controlled. Rights of access and permission to use certain forest products may be provided to villagers but, again, restrictions are imposed. There are six National Parks at present: Montagne d'Ambre, Isalo, Mantady, Ranomafana and two at Mananara-Nord, Vezanantsoro and Nosy Atafana. A seventh is being planned for the Masoala Peninsula.

Strict Nature Reserves (*Reserves Integrees*)

Legislation establishing the category of Strict Nature Reserve was passed in 1966. Access to these reserves is limited to officials of the Water and Forests Department and to researchers who have obtained permission from the appropriate government ministries. There are currently 11 Strict Nature Reserves in Madagascar. A twelfth, on the Masoala Peninsula, was degazetted in 1964 and is now an unprotected classified forest.

Special Reserves (*Reserves Speciales*)

Various laws have been passed to establish Special Reserves in Madagascar. In most cases, these reserves have been created to protect a particular species of plant or animal. Permission must be obtained to enter Special Reserves, but allowances are made for certain traditional rights of use. There are currently 23 Special Reserves, only some of which are guarded by officials of the Water and Forests Department.

Private Reserves

In addition to the system of officially protected areas, provision is also made for private reserves in Madagascar. Three such reserves currently exist, one at Analabe north of Morondava in the southwest, one at St. Luce on the east coast north of Fort Dauphin, and one at Berenty in the far south to the east of Fort Dauphin.

Table 4
Protected Areas of Madagascar

National Parks

Isalo	81,540 ha
Ranomafana	41,600
Vezanantsoro	23,000
Nosy Atafana	1,000
Montagne d'Ambre	18,200
Mantady	10,000

Strict Nature Reserves

Tsingy de Bemaraha	152,000 ha
Andohahela	76,020
Zahamena	73,160
Ankarafantsika	60,520
Marojejy	60,150
Tsaratana	48,622
Tsimanampetsotsa	43,200
Andringitra	31,160
Namoroka	21,742
Betampona	2,228
Lokobe	740

Special Reserves

Ambatovaky	60,050 ha
Marotandrano	42,200
Manongarivo	35,250
Analamera	34,700
Anjanaharibe-Sud	32,100
Kalambatritra	28,250
Ambohijanahary	24,750
Kasijy	18,800
Ankarana	18,220
Analamaitso	17,150
Mangerivola	11,900
Bemarivo	11,570
Maningozo	7,900
Andranomena	6,420
Ambohitantely	5,600
Manombo	5,020
Foret d'Ambre	4,810
Bora	4,780
Pic d'Ivohibe	3,450
Cap Sainte-Marie	1,750
Analamazaotra	810
Beza-Mahafaly	600
Nosy Mangabe	520

Private Reserves

Analabe	2,000-12,000 ha (?)
Berenty	265
St. Luce	200

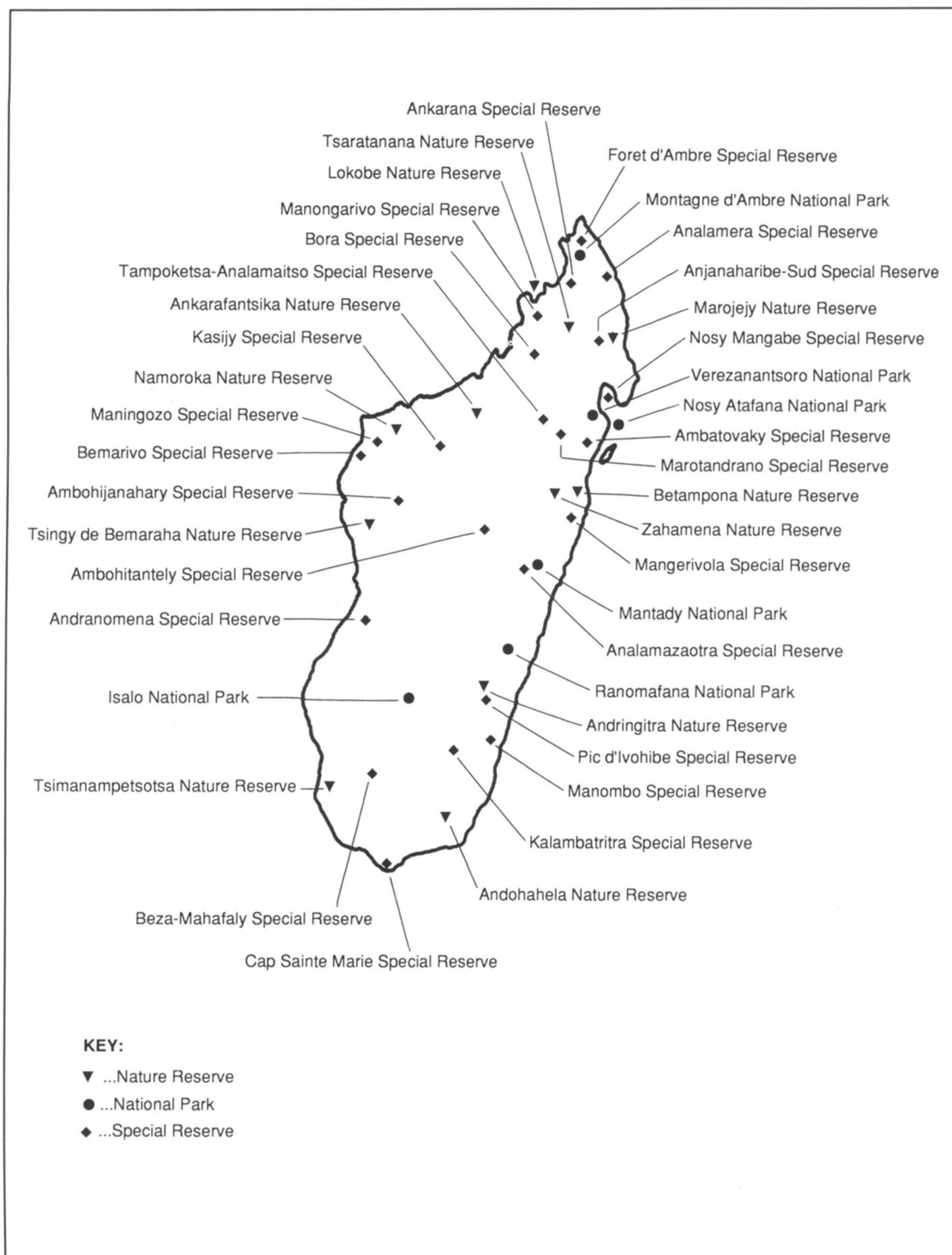


Figure 2. National Parks, Nature Reserves and Special Reserves of Madagascar

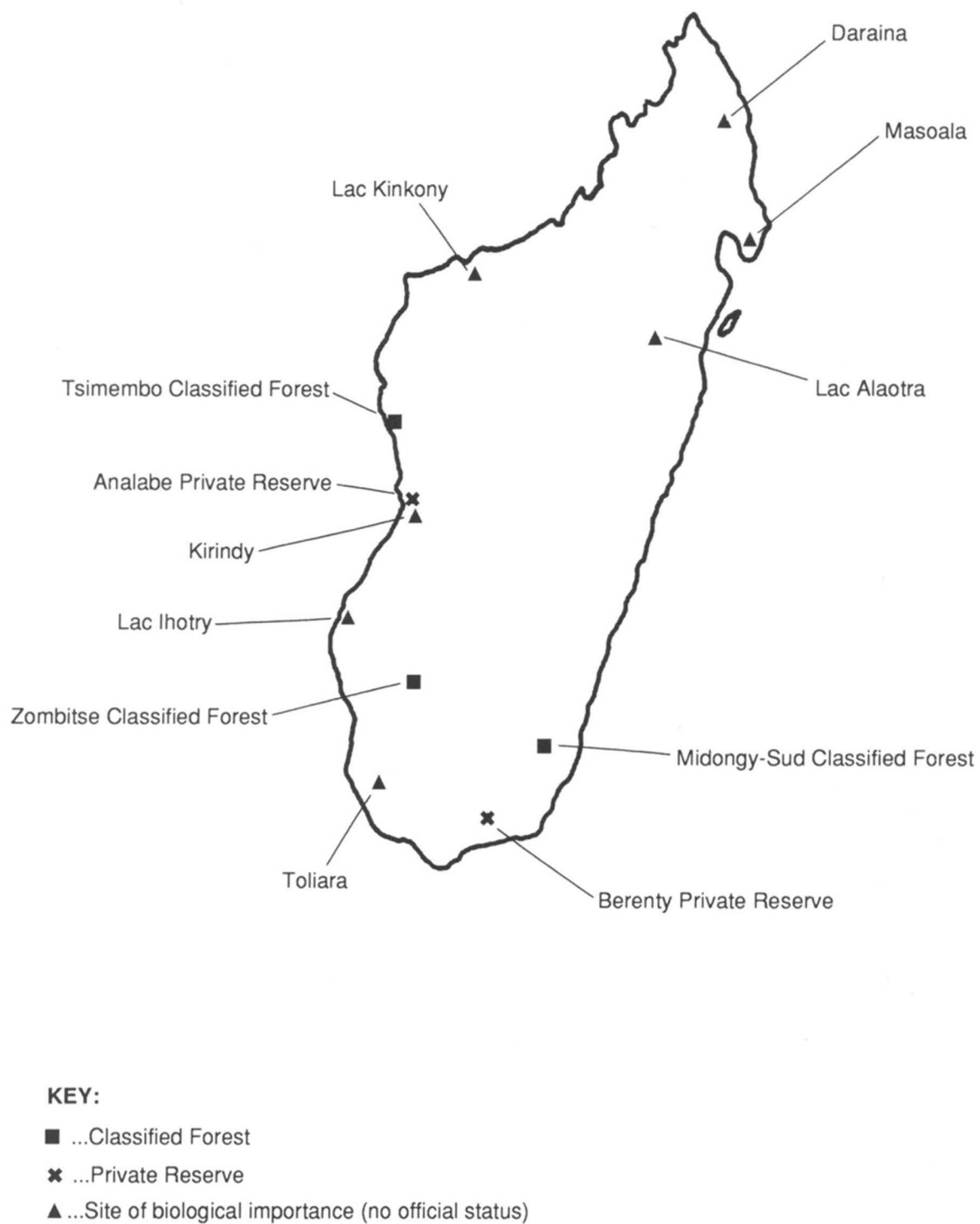


Figure 3. Private Reserves, Classified Forests and other sites of biological importance in Madagascar.

Table 5
Lemur Taxa Present in Protected Areas of Madagascar

Eastern Region					
Protected Area	Domains				Lemur Taxa Present
	Eastern	Central	Sambirano	High Mountain	
Ambatovaky Special Reserve (60,050 ha)	51,050	9,000			<i>Microcebus rufus</i> <i>Cheirogaleus major</i> <i>Eulemur f. fulvus</i> <i>Eulemur rubriventer</i> <i>Lepilemur</i> sp. <i>Hapalemur g. griseus</i> <i>Varecia variegata variegata</i> <i>Avahi l. laniger</i> <i>Indri indri</i> <i>Propithecus d. diadema</i> <i>Daubentonia madagascariensis</i>
Verezanantsoro National Park (24,000 ha)	23,000				<i>Microcebus rufus</i> <i>Cheirogaleus major</i> <i>Allocebus trichotis</i> <i>Eulemur fulvus</i> <i>Varecia variegata variegata</i> <i>Hapalemur g. griseus</i> <i>Indri indri</i> <i>Propithecus d. diadema</i> <i>Daubentonia madagascariensis</i>
Mangerivola Special Reserve (11,900 ha)	11,900				?
Manombo Special Reserve (5,020 ha)	5,020				<i>Microcebus rufus</i> <i>Cheirogaleus</i> sp. <i>Eulemur fulvus albocollaris</i> <i>Hapalemur g. griseus</i> <i>Avahi l. laniger</i> <i>Daubentonia madagascariensis</i>
Betampona Special Reserve (2,228 ha)	2,228				<i>Microcebus rufus</i> <i>Cheirogaleus major</i> <i>Phaner furcifer</i> <i>Lepilemur mustelinus</i> <i>Eulemur fulvus</i> <i>Varecia variegata variegata</i> <i>Hapalemur g. griseus</i> <i>Avahi l. laniger</i> <i>Indri indri</i> <i>Propithecus d. diadema</i> <i>Daubentonia madagascariensis</i>
Nosy Mangabe Special Reserve (520 ha)	520				<i>Cheirogaleus major</i> <i>Microcebus rufus</i> <i>Eulemur fulvus albifrons</i> <i>Varecia variegata variegata</i> <i>Daubentonia madagascariensis</i>

Protected Area	Domains				Lemur Taxa Present
	Eastern	Central	Sambirano	High Mountain	
Isalo National Park (81,540 ha)		81,540			<i>Lemur catta</i> <i>Eulemur fulvus</i> <i>Propithecus v. verreauxi</i>
Zahamena Nature Reserve (73,160)	5,124	68,040			<i>Microcebus rufus</i> <i>Cheirogaleus major</i> <i>Phaner f. furcifer</i> <i>Lepilemur m. mustelinus</i> <i>Hapalemur g. griseus</i> <i>Eulemur fulvus</i> <i>Eulemur rubriventer</i> <i>Varecia variegata variegata</i> <i>Avahi l. laniger</i> <i>Indri indri</i> <i>Propithecus d. diadema</i> <i>Daubentonia madagascariensis</i>
Andohahela Nature Reserve - Parcel 1 * (63,100 ha)	6,300	56,800			<i>Microcebus rufus</i> <i>Cheirogaleus major</i> <i>Lepilemur mustelinus</i> <i>Lemur catta</i> <i>Eulemur fulvus collaris</i> <i>Hapalemur g. griseus</i> <i>Avahi l. laniger</i> <i>Propithecus diademi edwardsi</i> <i>Propithecus v. verreauxi</i> <i>Daubentonia madagascariensis</i>
Marotandrano Special Reserve (42,200 ha)	42,200				?
Marojejy Nature Reserve (60,150 ha)	12,030	42,105		6,015	<i>Microcebus rufus</i> <i>Cheirogaleus major</i> <i>Lepilemur mustelinus</i> <i>Eulemur rubriventer</i> <i>Eulemur fulvus albifrons</i> <i>Hapalemur g. griseus</i> <i>Avahi l. laniger</i> <i>Propithecus diadema candidus</i> <i>Daubentonia madagascariensis</i>
Ranomafana National Park (41,600 ha)		41,600			<i>Microcebus rufus</i> <i>Cheirogaleus major</i> <i>Lepilemur sp.</i> <i>Eulemur rubriventer</i> <i>Eulemur fulvus rufus</i> <i>Hapalemur g. griseus</i> <i>Hapalemur aureus</i> <i>Hapalemur simus</i> <i>Avahi l. laniger</i> <i>Varecia variegata variegata</i> <i>Propithecus diadema edwardsi</i> <i>Daubentonia madagascariensis</i>

Protected Area	Domains				Lemur Taxa Present
	Eastern	Central	Sambirano	High Mountain	
Tsaratanana Special Reserve (48,622 ha)	8,270	36,952		3,400	<i>Cheirogaleus major</i> <i>Phaner furcifer</i> <i>Lepilemur mustelinus</i> <i>Eulemur m. macaco</i> <i>Eulemur rubriventer</i> <i>Eulemur f. fulvus</i> <i>Hapalemur g. griseus</i>
Anjanaharibe-Sud Special Reserve (32,100 ha)	1,600	30,500			<i>Microcebus rufus</i> <i>Cheirogaleus major</i> <i>Eulemur fulvus albifrons</i> <i>Hapalemur g. griseus</i> <i>Avahi l. laniger</i> <i>Indri indri</i> <i>Propithecus diadema candidus</i>
Kalambatritra Special Reserve (28,250 ha)		28,250			<i>Eulemur fulvus rufus</i>
Ambohijanahary Special Reserve (24,750 ha)		24,750			<i>Propithecus verreauxi deckeni</i>
Andringitra Nature Reserve (31,160 ha)	1,600	21,860		7,700	<i>Microcebus rufus</i> <i>Lepilemur microdon</i> <i>Lemur catta</i> <i>Eulemur rubriventer</i> <i>Eulemur fulvus rufus</i> <i>Varecia variegata variegata</i> <i>Avahi l. laniger</i>
Montagne d'Ambre National Park (18,200 ha)		18,200			<i>Microcebus rufus</i> <i>Cheirogaleus major</i> <i>Phaner furcifer</i> <i>Eulemur fulvus sanfordi</i> <i>Eulemur coronatus</i> <i>Lepilemur septentrionalis</i> <i>Daubentonia madagascariensis</i>
Tampoketsa-Analamaitso Special Reserve (17,150 ha)		17,150			?
Mantady National Park (10,000 ha)		10,000			<i>Microcebus rufus</i> <i>Cheirogaleus major</i> <i>Lepilemur microdon</i> <i>Eulemur rubriventer</i> <i>Eulemur fulvus fulvus</i> <i>Hapalemur g. griseus</i> <i>Varecia variegata variegata</i> <i>Avahi l. laniger</i> <i>Indri indri</i> <i>Daubentonia madagascariensis</i>

Protected Area	Domains			Lemur Taxa Present
	East	Central	Sambirano	
Ambohitantely Special Reserve (5,600 ha)		5,600		<i>Microcebus rufus</i> <i>Eulemur f. fulvus</i> <i>Avahi l. laniger</i>
Foret d'Ambre Special Reserve (4,810 ha)		4,810		<i>Microcebus rufus</i> <i>Cheirogaleus major</i> <i>Phaner furcifer</i> <i>Lepilemur septentrionalis</i> <i>Eulemur coronatus</i> <i>Eulemur fulvus sanfordi</i> <i>Daubentonia madagascariensis</i>
Analamazaotra Special Reserve (810 ha)		810		<i>Microcebus rufus</i> <i>Cheirogaleus major</i> <i>Lepilemur microdon</i> <i>Eulemur rubriventer</i> <i>Eulemur fulvus</i> <i>Hapalemur g. griseus</i> <i>Varecia variegata variegata</i> <i>Avahi l. laniger</i> <i>Indri indri</i> <i>Daubentonia madagascariensis</i>
Manongarivo Special Reserve (35,250 ha)			35,250	<i>Microcebus rufus</i> <i>Cheirogaleus major</i> <i>Phaner furcifer</i> <i>Lepilemur dorsalis</i> <i>Eulemur m. macaco</i> <i>Eulemur f. fulvus</i> <i>Hapalemur g. griseus</i> and/or <i>occidentalis</i> <i>Daubentonia madagascariensis</i>
Lokobe Nature Reserve (740 ha)			740	<i>Microcebus rufus</i> <i>Eulemur m. macaco</i> <i>Lepilemur dorsalis</i>
Pic d'Ivohibe Special Reserve (3,450 ha)				3,450 <i>Eulemur fulvus rufus</i> <i>Propithecus diadema edwardsi</i>

* Also includes a portion in the Western Region

Western Region

Protected Area	Western	Domains		Lemur Taxa Present
		Southern		
Tsingy de Bemahara Nature Reserve (152,000 ha)	152,000			<i>Microcebus murinus</i> <i>Mirza coquereli</i> <i>Phaner furcifer</i> <i>Lepilemur edwardsi</i> <i>Hapalemur griseus</i> <i>occidentalis</i> <i>Eulemur fulvus rufus</i> <i>Propithecus verreauxi deckeni</i>
Ankarafantsika Nature Reserve (60,520 ha)	60,520			<i>Microcebus murinus</i> <i>Cheirogaleus medius</i> <i>Lepilemur edwardsi</i> <i>Eulemur mongoz</i> <i>Eulemur f. fulvus</i> <i>Avahi laniger occidentalis</i> <i>Propithecus verreauxi coquereli</i>
Analamera Special Reserve (34,700 ha)	34,700			<i>Microcebus murinus</i> <i>Phaner furcifer electromontis</i> <i>Lepilemur septentrionalis</i> <i>Eulemur coronatus</i> <i>Eulemur fulvus sanfordi</i> <i>Propithecus diadema perrieri</i> <i>Daubentonia madagascariensis</i>
Namoroka Nature Reserve (21,742 ha)	21,742			<i>Microcebus murinus</i> <i>Eulemur fulvus</i> <i>Lepilemur edwardsi</i> <i>Propithecus verreauxi</i>
Kasijy Special Reserve (18,800 ha)	18,800			?
Ankarana Special Reserve (18,200 ha)	18,200			<i>Microcebus murinus</i> <i>Microcebus rufus</i> <i>Cheirogaleus medius</i> <i>Phaner furcifer</i> <i>Lepilemur septentrionalis</i> <i>Eulemur coronatus</i> <i>Eulemur fulvus sanfordi</i> <i>Hapalemur griseus occidentalis</i> <i>Avahi laniger occidentalis</i> <i>Propithecus diadema perrieri</i> <i>Daubentonia madagascariensis</i>
Bemarivo Special Reserve (11,570 ha)	11,570			?
Maningozo Special Reserve (7,900 ha)	7,900			?

Protected Area	Domains		Lemur Taxa Present
	Western	Southern	
Andranomena Special Reserve (6,420 ha)	6,420		<i>Microcebus murinus</i> <i>Mirza coquereli</i> <i>Cheirogaleus medius</i> <i>Phaner furcifer</i> <i>Lepilemur ruficaudatus</i> <i>Eulemur fulvus rufus</i> <i>Propithecus v. verreauxi</i>
Bora Special Reserve (4,780 ha)	4,780		<i>Eulemur fulvus</i> <i>Propithecus verreauxi</i> (?)
Analabe Private Reserve (2,000-12,000 ha)	?		<i>Microcebus murinus</i> <i>Mirza coquereli</i> <i>Cheirogaleus medius</i> <i>Phaner furcifer</i> <i>Lepilemur ruficaudatus</i> <i>Eulemur fulvus rufus</i> <i>Propithecus v. verreauxi</i>
Tsimanampetsotsa Nature Reserve (43,200 ha)		43,200	<i>Microcebus murinus</i> <i>Lemur catta</i> <i>Propithecus v. verreauxi</i>
Andohahela Nature Reserve — Parcels 2,3 *		12,920	<i>Microcebus murinus</i> <i>Cheirogaleus medius</i> <i>Phaner furcifer</i> <i>Lepilemur leucopus</i> <i>Lemur catta</i> <i>Propithecus v. verreauxi</i>
Cap Sainte Marie Special Reserve (1,750 ha)		1,750	<i>Microcebus murinus</i>
Beza-Mahafaly Special Reserve (600 ha)		600	<i>Microcebus murinus</i> <i>Cheirogaleus medius</i> <i>Lepilemur leucopus</i> <i>Lemur catta</i> <i>Propithecus v. verreauxi</i>
Berenty Private Reserve (265 ha)		265	<i>Microcebus murinus</i> <i>Cheirogaleus medius</i> <i>Lepilemur leucopus</i> <i>Lemur catta</i> <i>Eulemur fulvus rufus</i> ** <i>Propithecus v. verreauxi</i>

* See also Eastern Region for other portions of Andohahela

** Introduced

Unprotected Areas of Biological Importance

In their report to the World Wide Fund for Nature on conservation and protected areas in Madagascar, Nicoll and Langrand (1989) describe 18 sites of biological interest (referred to as Areas of Biological Importance in this document), including Classified Forests and buffer zones surrounding Biosphere Reserves. Subsequent to Nicoll and Langrand's report, the status of two sites of biological interest, Mananara-Nord and Ranomafana, has been upgraded to create three National Parks, (Vezanantsoro, Nosy Atafana and Ranomafana) the first two representing the core area for Madagascar's first Biosphere Reserve.

In this section, we present information on several other areas of biological importance (Fig. 3), including their location within Madagascar's biogeographic regions, the potential size of proposed protected areas and the lemur taxa reported.

Biosphere Reserves

The first Biosphere Reserve in Madagascar was established in 1989 at Mananara-Nord. It contains a strict conservation zone

with the status of a National Park (23,000 ha terrestrial and 1,000 ha marine) surrounded by a buffer zone which is not legally protected. However, natural resources in the buffer zone are meant to be used on a sustainable basis.

Classified Forests

Classified Forests are created by individual ministerial decrees and with the involvement of local authorities. Exploitation of these reserves is illegal, exceptions being made only for the use of certain traditional forest products. There are approximately 160 Classified Forests in Madagascar, covering an area in excess of 2,500,000 ha, but protection of these lands is not necessarily permanent. Indeed, it is often weak to nonexistent.

Note: Of the large number of Classified Forests established in Madagascar, only a few are referred to in this document. Those listed below have been described by Nicoll and Langrand (1989) as sites of biological interest and are believed to be of significance to lemur conservation.

Table 6
Lemur Taxa Present in Unprotected Areas of Biological Importance

Eastern Region					
Domains					
Site	Eastern	Central	Sambirano	Mountain	Lemur Taxa Present
Midongy-Sud Classified Forest (67,578 ha)		67,578			<i>Eulemur fulvus</i> <i>Hapalemur</i> sp. <i>Propithecus diadema</i> (?) <i>Daubentonia madagascariensis</i> ?
Zombitse Classified Forest (21,500 ha)		21,500			<i>Microcebus murinus</i> <i>Phaner furcifer</i> <i>Lepilemur ruficaudatus</i> <i>Lemur catta</i> <i>Eulemur fulvus rufus</i> <i>Propithecus v. verreauxi</i>
Lac Alaotra (47,000 ha)		47,000			<i>Hapalemur griseus alaotrensis</i>
Masoala Peninsula (300,000 ha)		300,000			<i>Microcebus rufus</i> <i>Cheirogaleus major</i> <i>Phaner furcifer</i> <i>Lepilemur</i> sp. <i>Eulemur fulvus albifrons</i> <i>Hapalemur g. griseus</i> <i>Varecia variegata rubra</i> <i>Avahi l. laniger</i> <i>Daubentonia madagascariensis</i> (?)
Daraina		20,000			<i>Microcebus rufus</i> <i>Cheirogaleus medius</i> <i>Phaner furcifer electromontis</i> <i>Lepilemur septentrionalis</i> <i>Eulemur coronatus</i> <i>Eulemur fulvus sanfordi</i> <i>Propithecus tattersalli</i> <i>Daubentonia madagascariensis</i>

Western Region

Site	West	Domains South	Lemurs Present
Tsimembo Classified Forest (approx. 125,000 ha)	125,000		<i>Microcebus murinus</i> <i>Cheirogaleus medius</i> <i>Phaner furcifer</i> <i>Lepilemur edwardsi</i> <i>Hapalemur griseus occidentalis</i> <i>Eulemur fulvus fulvus</i> <i>Propithecus verreauxi deckeni</i>
Kirindy Forest and Ampataka Classified Forest approx. 60,000 ha	approx. 60,000		<i>Microcebus murinus</i> <i>Mirza coquereli</i> <i>Cheirogaleus medius</i> <i>Phaner furcifer</i> <i>Lepilemur ruficaudatus</i> <i>Eulemur fulvus rufus</i> <i>Propithecus v. verreauxi</i>
Lac Kinkony Classified Forest (10,000-15,000 ha)	10,000-15,000		<i>Eulemur fulvus rufus</i> <i>Propithecus verreauxi deckeni</i>
Toliara Forest (12,500 ha)		approx. 12,500	<i>Microcebus murinus</i> <i>Lemur catta</i> <i>Eulemur fulvus</i>
Lac Ihotry Classified Forest (960-11,200 ha)		960-11,200	<i>Lemur catta</i> <i>Eulemur fulvus</i> <i>Propithecus v. verreauxi</i>

Section 4: Lemur Taxa of Conservation Concern

Highest Priority

Aye-Aye

Daubentonia madagascariensis

The aye-aye is the only living representative of the family Daubentonidae. It is an elusive nocturnal lemur that appears to be widely, though sparsely, distributed throughout eastern, northern and northwestern Madagascar (Fig. 4). The aye-aye seems very adaptable and is found in areas of primary and secondary rain forest, deciduous forest, secondary growth, dry scrub forest and cultivated areas (Tattersall, 1982).

Daubentonia spends the day in a nest, usually built in the fork of a tree or in vine tangles. Single individuals are most commonly observed. The aye-aye's diet consists largely of fruits, principally coconuts, and insect larvae (Petter, 1977), but they are reported to eat a wide variety of items including plant galls, bamboo tree bark, adult insects and small vertebrates (Petter and Petter-Rousseaux, 1967; Pollock *et al.*, 1985; Iwano and Iwakaw, 1988). It appears that the aye-aye may give birth once every two to three years (Petter and Peyrieras, 1970a).

The aye-aye is found in both the Eastern and Western Regions of Madagascar, and has a larger distribution than was originally believed. It has been reported from the following protected areas: the Verezanantsoro, Mantady, Montagne d'Ambre and Ranomafana National Parks; the Andohahela, Bemaraha, Betampona, Marojejy and Zahamena Nature Reserves; the Ambatovaky, Analamazaotra, Analamera, Ankarana, Foret d'Ambre, Manombo, and Manongarivo Special Reserves, and it was introduced to the Nosy Mangabe Special Reserve in 1966 (Ganzhorn, 1986; O'Connor *et al.*, 1986; Albignac, 1987; Petter and Andriatsarafara, 1987; Raxworthy and Rakotondraparany, 1988; Wright, 1988; Nicoll and Langrand, 1989; Safford *et al.*, 1989; Thompson and Evans, 1991; Hawkins *et al.*, in press). Aye-aye have recently been sighted in the forests surrounding Daraina (D. Meyers, pers. comm.) Eleanor Sterling of Yale

University has recently completed two years of field research on the aye-ayes of Nosy Mangabe.

Estimates of aye-aye populations are needed for each of the protected areas listed above. In addition, most of the above-mentioned areas require better protection, as well as public awareness campaigns to discourage killing of aye-ayes. Albignac (1988) suggests that such programs compensate local people for damage done by aye-ayes to their crops. Searches for new aye-aye populations should be conducted in the Marotrandrano and Tampoketsa-Analamaitso Special Reserves and the Midongy-Sud Classified Forest. Creation of new protected areas around the city of Maroantsetra and on the Masoala Peninsula should also help safeguard the aye-aye's future.

The captive breeding effort for this species should be expanded beyond the small colonies that currently exist at the Jersey Wildlife Preservation Trust, Vincennes Zoo and the Duke University Primate Center, which now total about 10 animals.

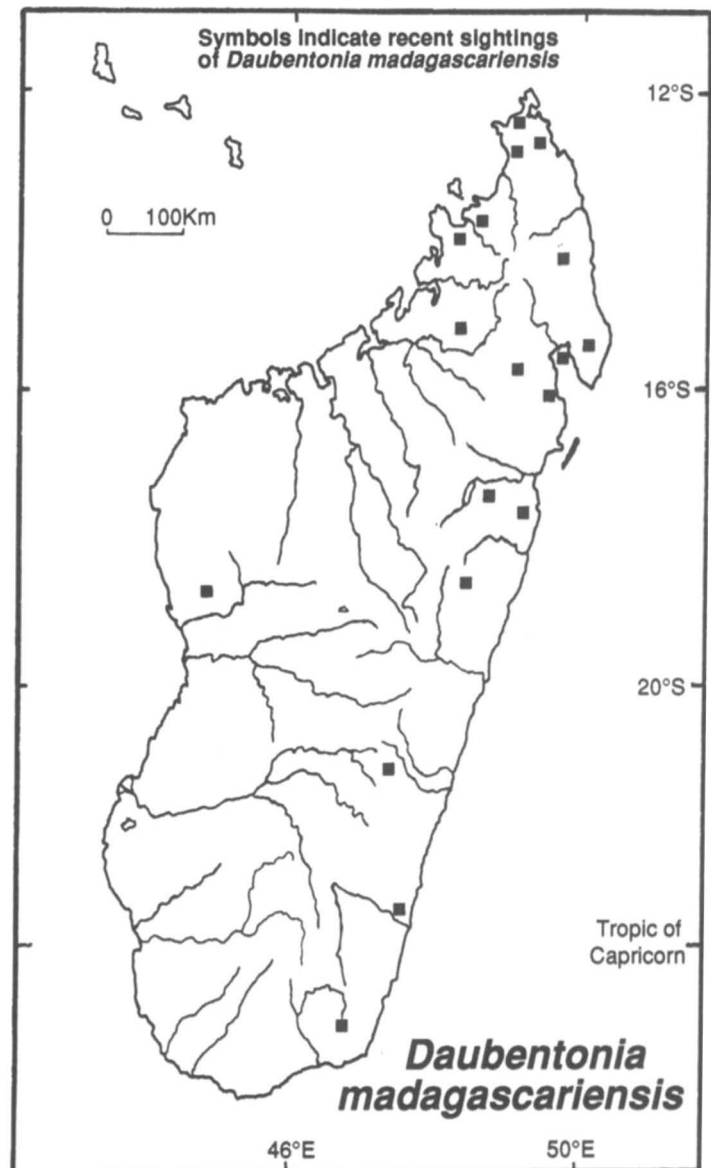


Figure 4. Distribution of *Daubentonia madagascariensis*.



Captive aye-aye (*Daubentonia madagascariensis*) at the Duke University Primate Center.



Bernhard Meier

The recently rediscovered hairy-eared dwarf lemur (*Allocebus trichotis*).

Hairy-Eared Dwarf Lemur

Allocebus trichotis

Until its rediscovery in 1989 in northeast Madagascar, the tiny, hairy-eared dwarf lemur, a monotypic genus, was known from only five museum specimens. Meier and Albignac (1989) consider that the distribution of *Allocebus trichotis* may be restricted and patchy. Its numbers are almost certainly declining as the eastern rain forests continue to be cut (Richard and Sussman, 1975, 1987).

Little is known about this nocturnal species, but it appears to occur only in lowland rain forest. Local people reported that they did not see active hairy-eared dwarf lemurs between May and September, and it appears that they are in some kind of hibernation during that time (Meier and Albignac, 1989). The animals are usually found sleeping in tree holes.

The main threat to this species is slash-and-burn agriculture. An area around the Vezanantsoro National Park (Fig. 5), the only known locality for *Allocebus*, has been designated as the Mananara-Nord Biosphere Reserve (Greve, 1991). Surveys are needed to locate other remaining populations of this species. Four *Allocebus* have been collected for captive breeding in conjunction with the Mananara-Nord Biosphere Reserve project (Meier and Albignac, 1989). This program should be expanded to include colonies abroad.

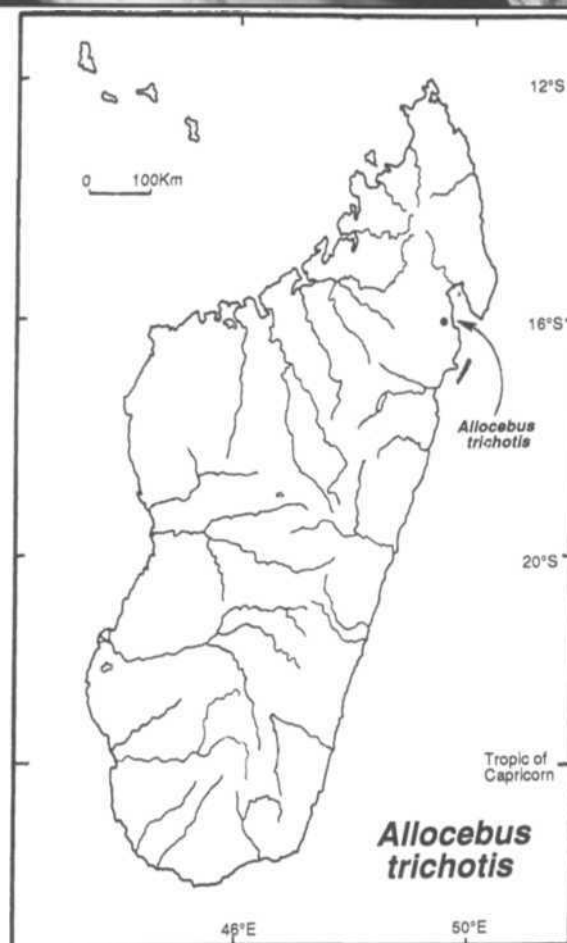


Figure 5. Distribution of *Allocebus trichotis*.

Sclater's Lemur

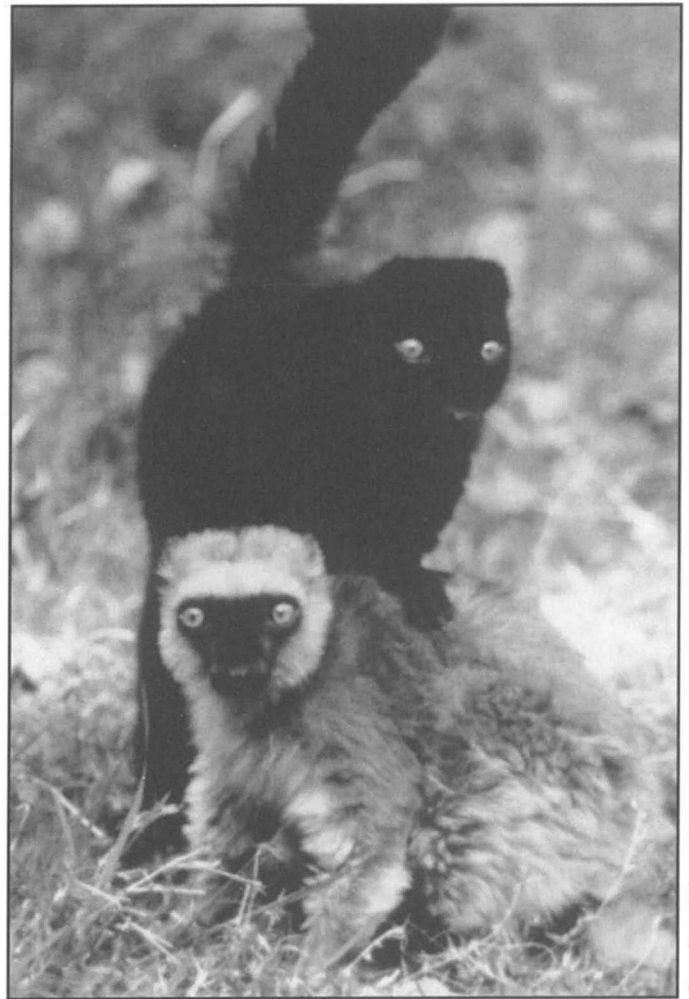
Eulemur macaco flavifrons

The black lemur (*Eulemur macaco*) occurs in the evergreen forests of the Sambirano region in northwestern Madagascar, as well as on the islands of Nosy Be and Nosy Komba and several smaller islands in the Nose Be area. Two subspecies are recognized, *Eulemur m. macaco* and *E. m. flavifrons*, the latter regarded as endangered.

Male Sclater's lemurs (*E. m. flavifrons*) are uniformly black, perhaps with a brown tint to the fur, while the females have a reddish-tan coat (Koenders *et al.*, 1985; Birkel, 1987). The subspecies is reported to occur from the Andranomalaza River in the north, south to the Sandrakota River, but is not known to occur in any protected area (Fig. 6).

Meyers *et al.* (1989) recently studied the distribution and status of *Lemur macaco* and found evidence of a geographical cline between *E. m. macaco* and *E. m. flavifrons*. Populations of what they considered pure *E. m. flavifrons* were small, patchy and found entirely outside the Sambirano region. Sclater's lemur is threatened by hunting, trapping and forest destruction for agricultural development (Koenders *et al.*, 1985).

In 1988, France's Strasbourg University and the Mulhouse Zoo proposed a conservation program for Sclater's lemur to the Malagasy Government, which included captive breeding efforts, field studies, creating a special reserve within its range and the training of a Malagasy student to work on the project (Lernould and Rumpler, 1988). This program is also supported by the Cologne Zoo, Saarbrücken Zoo and the Duke University Primate Center (Harcourt and Thornback, 1990). Subsequent recommendations by Meyers *et al.* (1989) focus heavily on conducting a socioeconomic survey of the Andranomalaza region, and changing current land-use practices to conserve forest habitat. They point out the difficulty in creating a special reserve that will protect a significant population of *E. m. flavifrons*, but suggest that increased protection of the Manongarivo Special Reserve will protect significant populations of *E. m. flavifrons* and *E. m. macaco* hybrids. Sclater's lemur has bred successfully at France's Mulhouse Zoo, and this captive breeding program should be expanded.



Russell A. Mittermeier

Male and (possibly hybrid) female Sclater's lemur.



David Meyers

Female Sclater's lemur (*Eulemur macaco flavifrons*).



Figure 6. Distribution of (*Eulemur macaco*) subspecies.

Red Ruffed Lemur

Varecia variegata rubra

The ruffed lemur (*Varecia variegata*) is an eastern rain forest species which does not appear to be common anywhere. Two subspecies are generally recognized; both are considered endangered. The coat of *Varecia variegata rubra* is primarily a deep rusty red with black extremities, forehead, crown, ventrum and tail. A patch of white fur occurs on the back of the neck.

The red ruffed lemur is restricted to the forests of the Masoala Peninsula (Figs. 7,17) (Petter *et al.*, 1977; Petter and Petter-Rousseaux, 1979; Tattersall, 1977a, 1982), parts of which have been heavily degraded for agricultural development (Simons and Lindsay, 1987). Very little information is available regarding the red ruffed lemur's conservation status, ecology or behavior. The only protected area in which it was known to occur, the former Masoala Nature Reserve, was degazetted in 1964 to permit timbering. Hunting and trapping of all lemurs is common in this area (Tattersall, 1977a; Constable *et al.*, 1985; Simons and Lindsay, 1987).

The Missouri Botanical Garden is actively involved in the creation of a national park on the Masoala Peninsula, with funding provided by USAID. A detailed survey of this region is needed to determine the distribution of the red ruffed lemur. A successful international captive breeding program is already underway which could possibly result in a reintroduction effort.



Photo courtesy of the San Diego Zoo

The red ruffed lemur (*Varecia variegata rubra*).

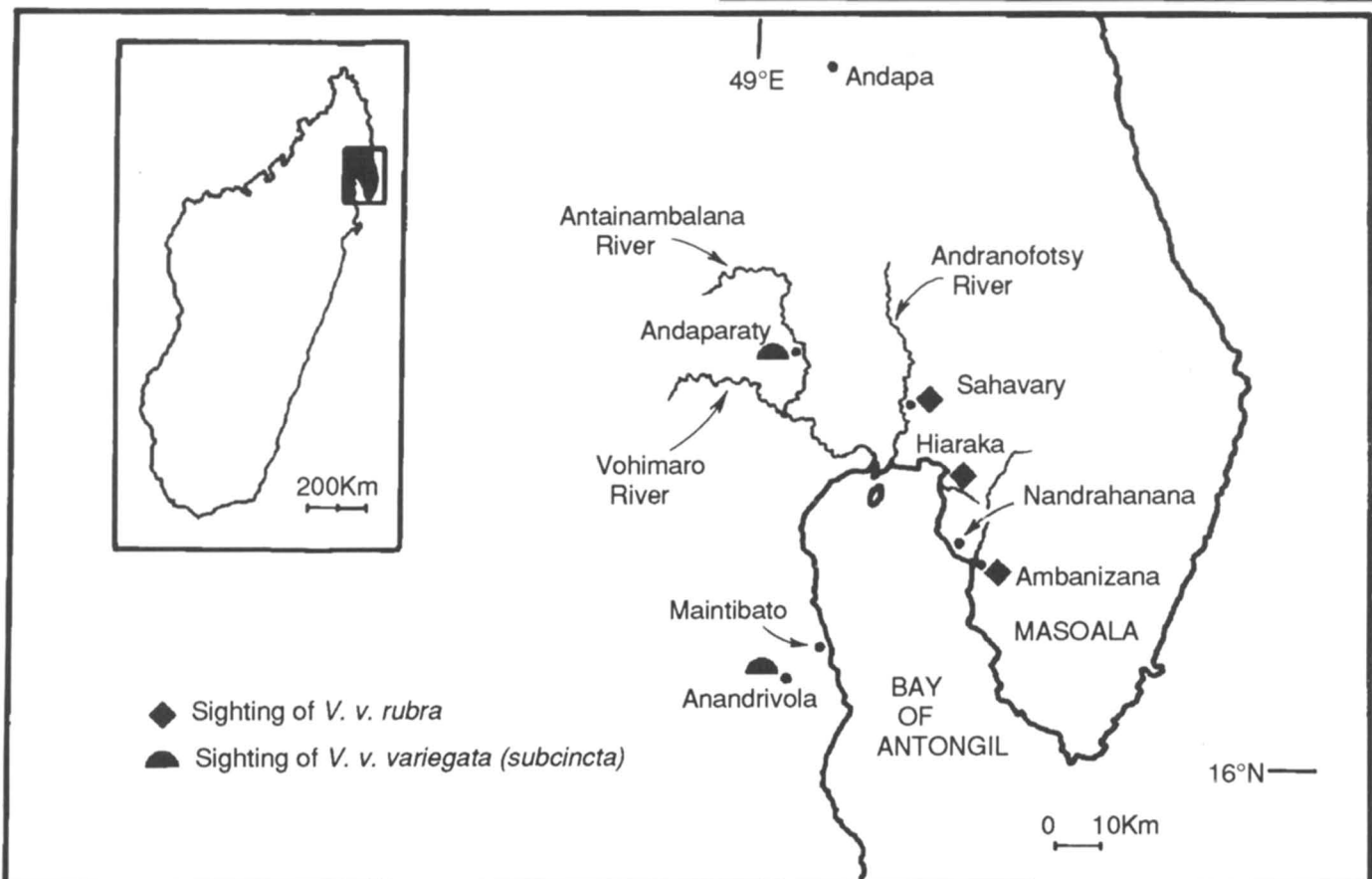


Figure 7. Distribution of *Varecia variegata rubra* and *Varecia variegata variegata* in the area of the Masoala Peninsula.

Golden Bamboo Lemur

Hapalemur aureus

The golden bamboo lemur was discovered only in 1987. A medium-sized gray-brown lemur with a black face and golden-yellow eyebrows, cheeks and throat, it is patchily distributed over a small area of rain forest in southeastern Madagascar. *Hapalemur aureus* is known to occur in only one protected area, the newly-created Ranomafana National Park (Figs. 8,9), where it is sympatric with both of the other members of the genus *Hapalemur*, the larger *H. simus* and the smaller *H. griseus* (Meier *et al.*, 1987). Its numbers in Ranomafana are estimated at 1,000 (P. Wright, pers. comm.).

The species feeds almost exclusively on plants of the family Graminae, particularly the giant bamboo (*Cephalostachium viguieri*), but also on bamboo creeper and bamboo grass (Meier *et al.*, 1987; Meier and Rumpler, 1987). It has been observed in groups of between two to six individuals (Meier *et al.*, 1987; Wright *et al.*, 1987) and appears to be active in the early morning and evening and is probably also active for part of the night.

Slash-and-burn agriculture is the main threat to this species. Surveys are needed to determine if the species survives in areas other than Ranomafana. Two *Hapalemur aureus* were taken into captivity at Madagascar's Parc Tsimbazaza, representing the "type" and the "paratype" of this newly-described species. This pair has successfully bred four times; three young survive. This captive breeding program should be expanded.



Golden bamboo lemur (*Hapalemur aureus*).



Russell A. Mittermeier

Greater bamboo lemur (*Hapalemur simus*).

Greater Bamboo Lemur or Broad-Nosed Gentle Lemur

Hapalemur simus

The greater bamboo lemur is now known from only the humid forest east of Fianarantsoa (Figs. 8,9) (Tattersall, 1982; Meier and Rumpler, 1987; Wright *et al.*, 1987), but the species used to be distributed throughout northern, northwestern, central and eastern Madagascar (Godfrey and Vuillaume-Randriamanantena, 1986). It is charcoal-gray in color with paler underparts and white ear tufts (Tattersall, 1982). This species may also occur in the forest of Ampasinambo, 80 km east of Ambositra, and there is a possibility that it might be discovered at Ankarana. Bamboo is plentiful in that area and recent feeding damage similar to that produced by the greater bamboo lemur was seen there in 1986 (Fowler *et al.*, 1989; Wilson *et al.*, 1989). The species is found in rain forest areas where there are considerable quantities of the giant bamboo (*Cephalostachium viguieri*). It has been seen in groups of up to seven individuals.

Habitat destruction by slash and burn agriculture and the cutting of bamboo are the major threats to *H. simus*. The population at Kianjavato is also threatened by hunting (Meier and Rumpler, 1987).

Currently, Ranomafana National Park is the only protected area in which *Hapalemur simus* is known to occur. P. Wright (pers. comm.) estimates its numbers in the 41,600 ha area to be about 1,000. Increased protection for Ranomafana is needed to reverse a 15-year trend of habitat destruction along its borders. Searches for new populations should be conducted in other areas, including Ankarana and Ampasinambo. Several greater bamboo lemurs have been taken into captivity in Europe. A captive breeding program should be established in Madagascar as well.

Lac Alaotra Bamboo Lemur

Haplemur griseus alaotrensis

There are three subspecies of bamboo or gentle lemur (*Haplemur griseus*), one of which, *H. g. griseus*, is widely distributed throughout the eastern rainforest. Another, *H. g. occidentalis*, occurs in two isolated populations in the west. The third, *H. g. alaotrensis*, is restricted to the reed beds of Lac Alaotra and the surrounding marshes (Figs. 8,10) (Petter *et al.*, 1977; Petter and Petter-Rousseaux, 1979; Tattersall, 1982).

The Lac Alaotra bamboo lemur is gray-brown in color and weighs about 1 kg. It is known to feed on the leaves and young shoots of the reed *Phragmites* and on the buds and pith of *Papyrus* in the wild and on bamboo in captivity (L. Durrell, pers. comm.). Although it normally moves about by clinging and leaping, it is also reported to swim very well. Group sizes range from three to four in certain seasons to congregations as large as 30-40 individuals at other times of the year (Petter and Peyrieras, 1970b, 1975).

This subspecies is severely threatened by habitat loss due to the annual burning of reed beds and the capture of these lemurs as food as they flee the fires (Petter and Peyrieras, 1970b; Jolly *et al.*, 1984). In addition, the lake is continually drained for rice irrigation and the reeds are cut to fashion mats, fish traps, screens, barriers and fencing (Pollock, 1986). The Lac Alaotra bamboo lemur is not found in any protected area.

Recommendations for the creation of a national park have been submitted to the Malagasy authorities. Two areas have been targeted for protection, 2,000 ha along the northern part and 3,000 ha along the central part of Lac Alaotra. A long-term field study should be initiated as soon as possible to determine this species needs. A small number of individuals were recently taken into captivity by the Jersey Wildlife Preservation Trust. This captive breeding program should be expanded.



Lac Alaotra bamboo lemur (*Haplemur griseus alaotrensis*).

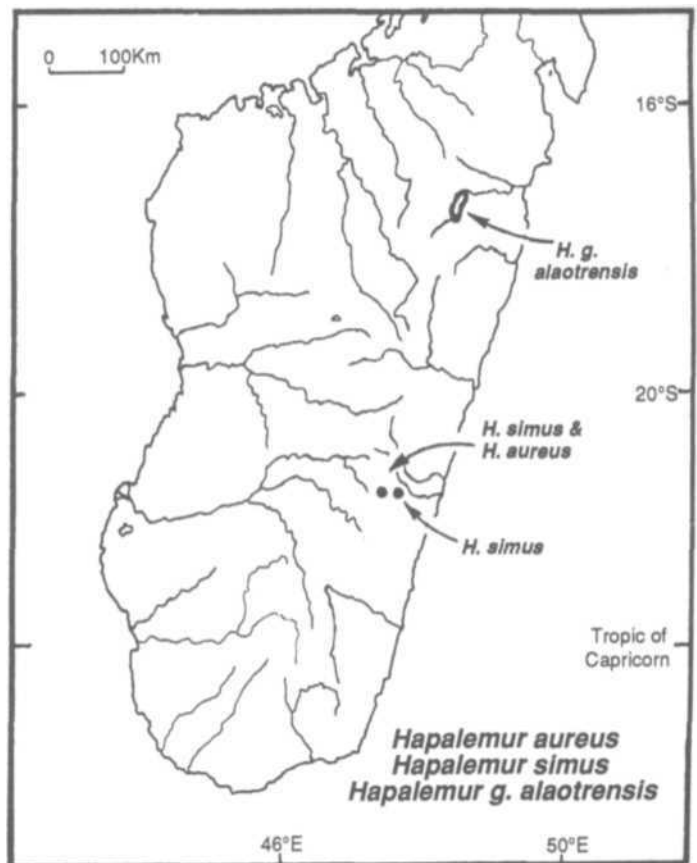


Figure 8. Distribution of *Haplemur aureus*, *Haplemur simus* and *Haplemur griseus alaotrensis*.

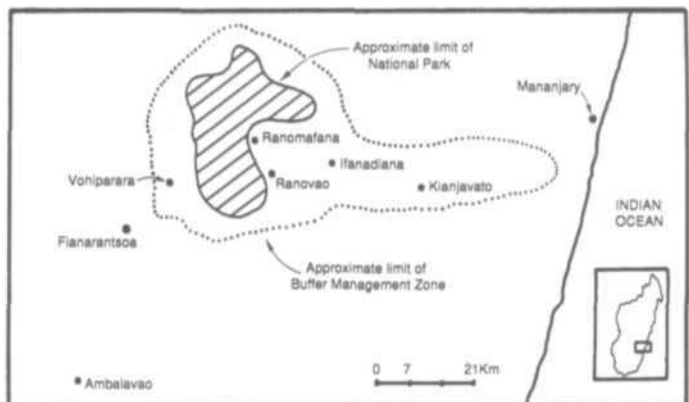


Figure 9. Ranomafana National Park and the region in which *Haplemur aureus* and *Haplemur simus* are known to occur.



Figure 10. The location of Lac Alaotra in relation to the Zahamena and Betampona Nature Reserves.

Indri

Indri indri

The indri is the largest living lemur, weighing 7-8 kg or more (Pollock, 1984), and is a monotypic genus. Its coloration is variable, mostly black with some white, gray or brown (Tattersall, 1982; Jenkins, 1987), and it is the only lemur species with only a stump of a tail. The indri is now confined to the eastern rain forest from the Mangoro River northwards to near the latitude of Sambava (Fig. 11), but excluding the Masoala Peninsula (Petter *et al.*, 1977; Tattersall, 1982). Population densities vary widely (Pollock, 1975).

Much of what we know about the ecology and behavior of this species comes from research conducted by Pollock (1975, 1977, 1979, 1984) mainly on one group at Perinet. Indri are strictly diurnal and live in groups of 2-5 individuals; loud morning calls advertise the presence of groups within their ranges. Indris feed on leaves, flowers and fruit. Females give birth to young every two to three years.

The main threat to *Indri indri* is slash-and-burn agriculture, a practice that continues even in protected areas. Although hunting remains a problem for many lemur species, it is taboo to hunt the indri in many areas. Nonetheless, the animal is



Russell A. Mittermeier

The indri (*Indri indri*) at the Perinet-Analamazaotra Reserve.

sometimes killed for food anyway, as was the case with Chinese workers on the Antananarivo-Tamatave road in the mid-1980s. The indri is reported to occur in the following protected areas: the newly-created Verezanantsoro and Mantady National Parks, the Betampona and Zahamena Nature Reserves, and the Ambatovaky, Analamazaotra and Anjanharibe-Sud Special Reserves (Nicoll and Langrand, 1989; Thompson and Evans, 1991). Based upon its geographic range, the indri may also be present in the Mangerivola and Marotandrano Special Reserves.

Surveys are needed to determine the size and status of indri populations in protected areas, and searches should also be conducted in areas not currently protected in order to determine the true distribution of this species. The indri has never been kept successfully in captivity, but a carefully planned program might be established in Madagascar.

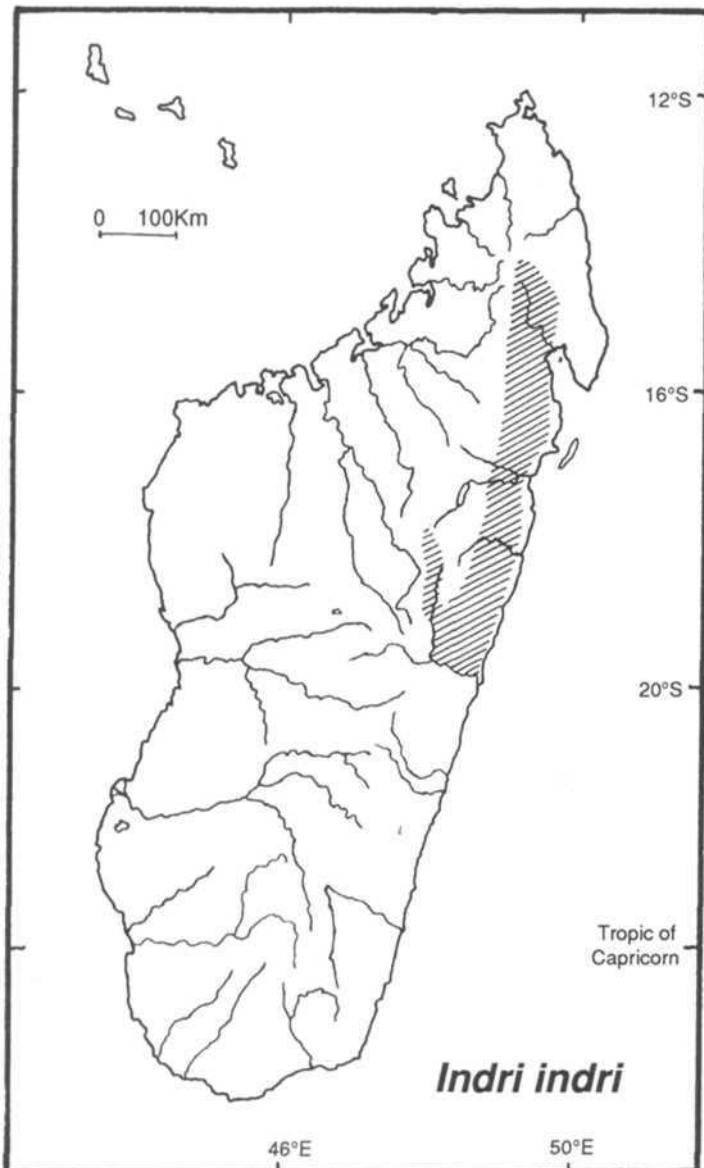


Figure 11. Distribution of the indri (*Indri indri*).

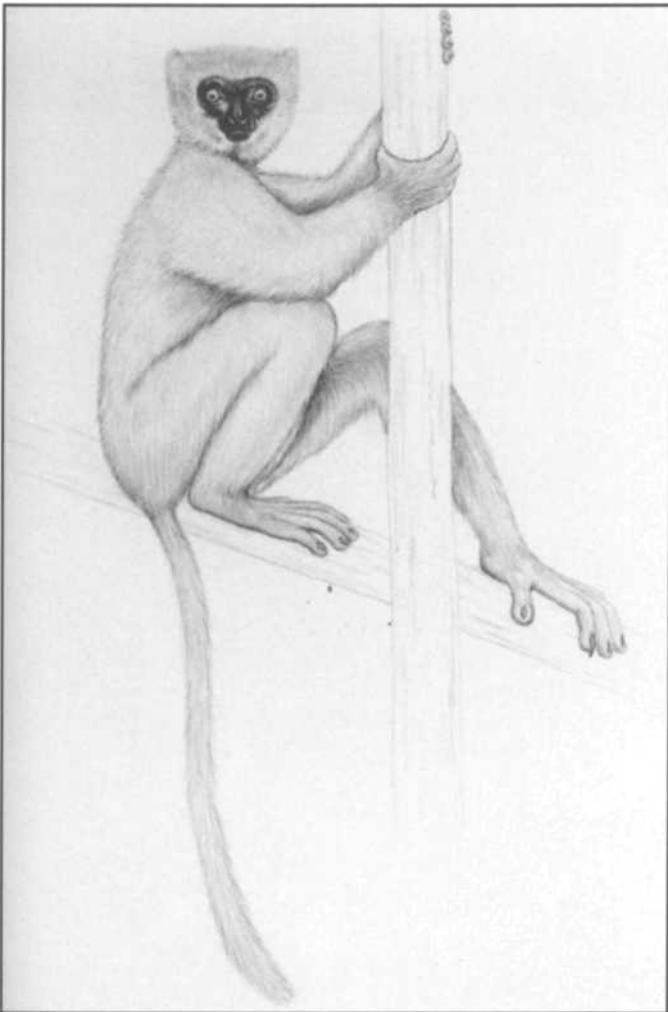
Silky Sifaka

Propithecus diadema candidus

Diademed sifakas (*Propithecus diadema* spp.) are large, diurnal lemurs found in Madagascar's eastern rain forest.

Propithecus diadema candidus is found north of Maroantsetra to the Andapa Basin and the Marojejy Massif (Fig. 12). Its numbers are unknown, but it appears to be rare throughout its range (Tattersall, 1982). The common English name for this subspecies comes from its dense silky white pelage. There have been no detailed studies of the silky sifaka, but brief observations suggest that groups are small and contain a dominant pair and their offspring. Habitat destruction is the major threat to this subspecies; it is also hunted even in protected areas (Safford *et al.*, 1989). *Propithecus diadema candidus* is known to inhabit the Marojejy Nature Reserve and the Anjanaharibe-Sud Special Reserve (Simona, 1988; Nicoll and Langrand, 1989; Safford *et al.*, 1989).

It is important to determine the status of the silky sifaka in the two protected areas in which it is known to occur, and to increase protection of these populations. In addition, searches for this subspecies should be made in the area northeast of Maroantsetra. Its presence would strengthen the proposal that has already been made for a new special reserve in that area. None are in captivity at present, but the Duke University Primate Center has developed protocols for *Propithecus* husbandry that could be useful in establishing captive colonies.



The silky sifaka (*Propithecus diadema candidus*).



Perrier's sifaka (*Propithecus diadema perrieri*).

Perrier's Sifaka

Propithecus diadema perrieri

Perrier's sifaka has long, dense and predominantly black fur. It is the rarest of the diademed Sifaka subspecies and is believed to be restricted to the drier forests south and east of Anivorano Nord (Figs. 12,13) (Petter *et al.*, 1977; Tattersall, 1982; Meyers and Ratsirarson, 1989).

Propithecus diadema perrieri is known to occur in the Analamera and Ankarana Special Reserves, but is apparently rare in the latter (Meyers and Ratsirarson, 1989; Hawkins *et al.*, in press). Based upon studies conducted in Analamera, group size ranges from one to six individuals; the diet includes mature leaves, unripe fruit, petioles, young leaves, stems and flowers. The total population of Perrier's sifaka is probably close to 2,000 (Meyers and Ratsirarson, 1989).

Threats to Perrier's sifaka are habitat destruction for agricultural development, fires, livestock grazing and the cutting of trees to produce charcoal. It is also hunted for food in the Analamera region. Meyers (pers. comm.) reports that the 100 km² area of this sifaka's range is only 50% forested, and that hunting appears to be on the rise in the southern part of its range. There is a local taboo against hunting sifakas in the Ankarana region (Fowler *et al.*, 1989) and in the northern part of their range (Meyers and Ratsirarson, 1989).

Better protection for Perrier's sifaka is needed in both the Analamera and Ankarana Reserves (Nicoll and Langrand,

1989). In addition, a well-protected forest corridor should be created between these two reserves (Harcourt and Thornback, 1990). Ecological studies should begin as soon as possible, and the feasibility of a captive breeding program should be evaluated.

Tattersall's Sifaka or Golden-Crowned Sifaka

Propithecus tattersalli

Tattersall's sifaka is a newly-described species with a very limited distribution in northeast Madagascar near Daraina (Figs. 12,13). Although original estimates of its population were in the low hundreds (Simons, 1988), Meyers and Ratsirarson (1989) have shown that it inhabits a much larger area than was originally thought. D. Meyers (pers. comm.) estimates that Tattersall's sifaka inhabits a region of about 1,500 km² (approximately 20% forested) at relatively high densities, and that the total population may be as high as 8,000.

Propithecus tattersalli is found primarily in dry forests, but it was recently observed in humid evergreen forests near Binara (Meyers and Ratsirarson, 1989). It has been observed in groups of three to six individuals and at densities of 60-70 individuals/km².

This species does not occur in any protected area at the present time. It is threatened by brush fires and loss of habitat to agriculture. Despite the fact that local custom in Daraina forbids the hunting or eating of lemurs, some gold miners attracted to this region do not respect this tradition.

Meyers and Ratsirarson (1989) have recommended that a national park of approximately 20,000 ha be created to protect *Propithecus tattersalli*, and that the park include the forests of Binara as well as those northeast of Daraina. Methods of sustainable land use must be employed around this protected area and a public education program launched. A long-term ecological study should begin as soon as possible.

A small captive colony was established several years ago at the Duke University Primate Center. This colony should be expanded and others created.

Crowned Sifaka

Propithecus verreauxi coronatus

Propithecus verreauxi is the most common and best-studied species in the genus, but it is still threatened by habitat destruction throughout its range.

The crowned sifaka (*P. v. coronatus*) is a uniformly light-colored animal with dark brown head, cheeks, throat, and inner arms. It is known from a small area of northwestern Madagascar just south of Mahajanga where its range adjoins that of *P. v. deckeni* to the southwest and *P. v. coquereli* to the northeast (Fig. 12). *P. v. coronatus* appears to be restricted to forests on the eastern side of the Mahavavy River (Rabemazava, 1990). As suggested by Tattersall (1982), the relationship between *coronatus* and *deckeni* remains to be clarified.

Very little information exists about this subspecies and it is not known to occur in any protected areas. Surveys of the Kasijy Special Reserve may identify new populations. Genetic analyses should be performed on sifakas inhabiting these protected areas, as well as on known populations of *P. v. deckeni*, to clarify the relationship between these two taxa. Several crowned sifakas are kept at the Vincennes Zoo in France.



David Haring

Tattersall's sifaka (*Propithecus tattersalli*).



Russell A. Mittermeier

Crowned sifaka (*Propithecus verreauxi coronatus*).

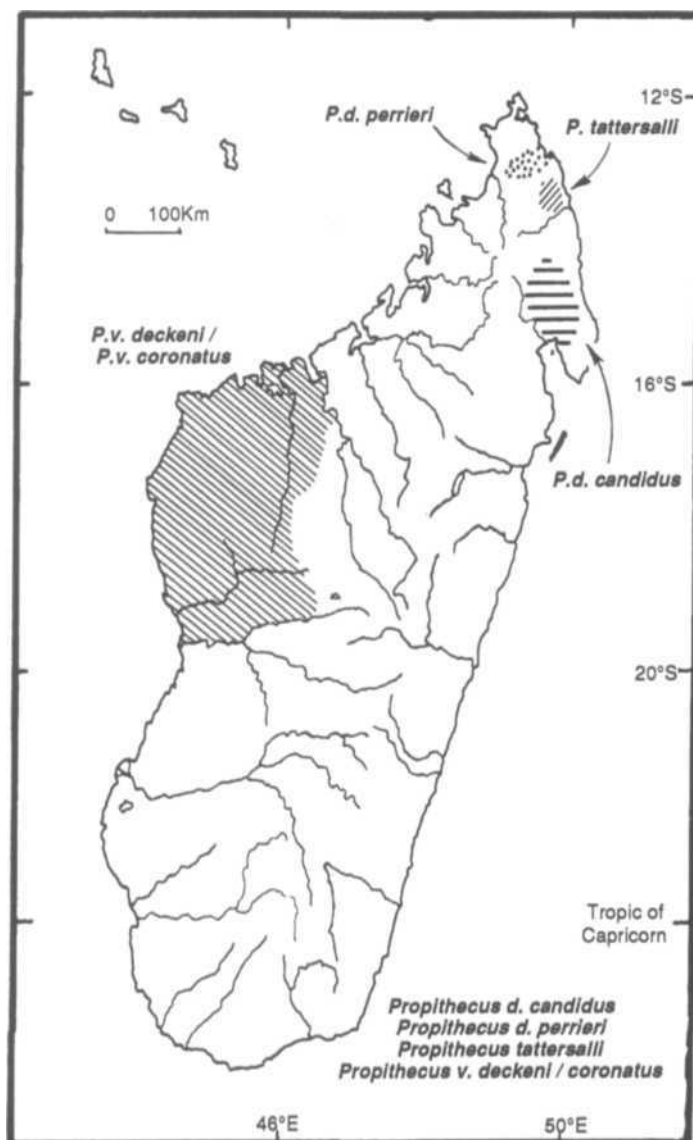


Figure 12. Distribution of *Propithecus*, *Propithecus diadema perrieri*, *Propithecus tattersalli* and *Propithecus verreauxi deckeni/coronatus*.

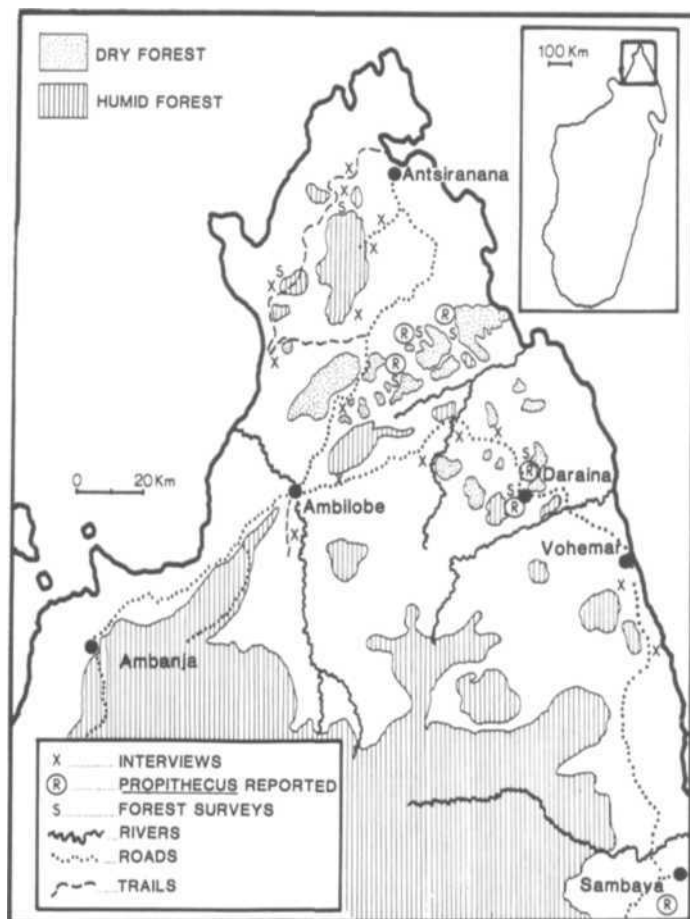


Figure 13. Occurrence of *Propithecus diadema perrieri* and *Propithecus tattersalli* in northern Madagascar.

High Priority

Coquerel's Dwarf Lemur

Mirza coquereli

Coquerel's dwarf lemur is a nocturnal species with a discontinuous distribution in areas of dry deciduous forest and the more humid Sambirano region in western Madagascar (Fig. 14). It weighs about 300g and has a grayish-brown coat. Its diet includes insects, spiders, frogs, chameleons, small birds, fruits, flowers, buds, gums and insect secretions (Petter *et al.*, 1971; Hladik *et al.*, 1980; Andrianarivo, 1981). *Mirza coquereli* spends the day in a nest made of vines, branches and leaves; in some areas these nests appear to be clustered in communities. Both sexes are territorial (Pages 1978, 1980).

Like other lemurs, *Mirza coquereli* is threatened by habitat destruction due to cultivation and fires. However, it appears to adapt well to secondary forest. It has been reported to occur in the Tsingy de Bemahara Nature Reserve, the Andranomena Special Reserve and the Analabe Private Reserve (Nicoll and Langrand, 1989).

Surveys of *Mirza coquereli* populations in the above-mentioned reserves are required, as are searches for other populations, beginning perhaps with the Kirindy and Tsimembo Classified Forests. Captive breeding programs have been established at a number of zoos and related institutions. These efforts should be better coordinated and a studbook established.

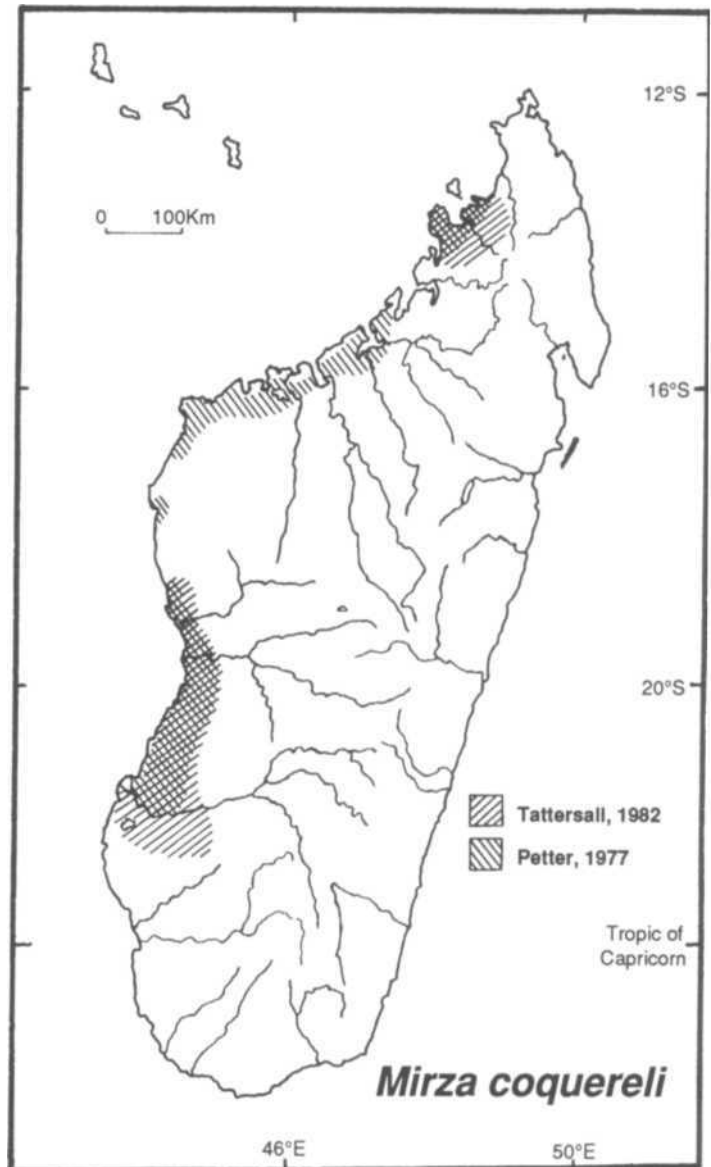


Figure 14. Distribution of *Mirza coquereli*.

Fork-Marked Dwarf Lemur

Phaner furcifer

The fork-marked dwarf lemur is a small nocturnal species with a wide but discontinuous distribution (Fig. 15). It inhabits both humid and dry deciduous forest as well as secondary forest (Harcourt and Thornback, 1990). Its color is gray-brown above with lighter underparts and a broad dark dorsal stripe that bifurcates on the crown, the two stripes continuing to the eyes (Tattersall, 1982).

Originally considered a monotypic species, *Phanerfurcifer* was recently divided into four subspecies by Groves and Tattersall (1991). *P. f. furcifer* is found on the Masoala Peninsula, *P. f. electromontis* in the area of Mt. d'Ambre, *P. f. pallescens* in western Madagascar from south of the Fiherenana River to the region of Soalala, and *P. f. parienti* in the Sambirano region. Disjunct populations have also been reported from the Tsaratanana Massif in the north and the Andohahela Nature Reserve in the south (Andriampianina and Peyrieras, 1972; Russell and McGeorge, 1977; Petter *et al.*, 1977; Petter and Petter-Rousseaux, 1979; Tattersall, 1982).



Benjamin Freed

Coquerel's dwarf lemur (*Mirza coquereli*) at the Duke University Primate Center.

The fork-marked dwarf lemur eats tree gums, sap, bud exudates, insects and larvae; it spends the day in tree holes or abandoned nests of other lemurs and is reported to be a very vocal species (Petter *et al.*, 1971, 1975; Charles-Dominique and Petter, 1980).

All four subspecies of *Phaner furcifer* are threatened by habitat destruction due to fires and the clearing of forest land for pasture and crops (Harcourt and Thornback, 1990).

Based upon a presumed distribution limited to the Masoala Peninsula, *Phanerf. furcifer* would not occur in any protected area. However, fork-marked dwarf lemurs have been reported from the Betampona and Zahamena Nature Reserves, and this probably represents *P. f. furcifer* (Jenkins, 1987; Katz, 1990; Daniels, 1991). *P. f. electromontis* is reported from the Montagne d'Ambre National Park, the Ankarana and Forêt d'Ambre Special Reserves, and from the forests near Daraina (D. Meyers, pers. comm.) *P. f. pallescens* is reported from the Tsingy de Bemaraha Nature Reserve, the Andranomena and Analamera Special Reserves the Analabe Private Reserve and the Kirindy. Tsimembo and Zombitse Classified Forests (Nicoll and Langrand, 1989). *P. f. parienti* is reported from the Manongarivo and Tsaratanana Special Reserves (Raxworthy and Rakotonirapany, 1988; Nicoll and Langrand, 1989; Hawkins *et al.*, in press). At present, it is not clear which subspecies is represented by the fork-marked dwarf lemur population reported from the Andohahela Nature Reserve in southeastern Madagascar.

Surveys of little-studied protected areas throughout Madagascar could very well identify new populations of *Phaner furcifer*, and these should be undertaken in conjunction with searches for other priority lemur taxa. In addition, genetic research is needed to clarify the taxonomy of *Phaner*.

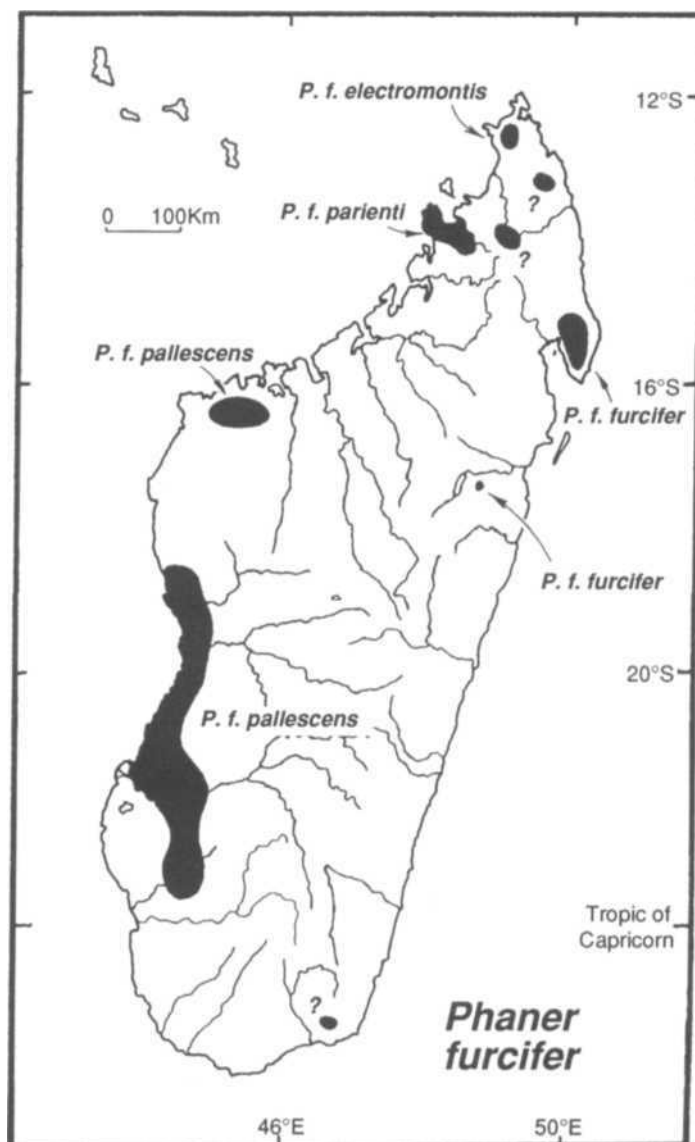


Figure 15. Distribution of *Phaner furcifer* subspecies.

Ring-Tailed Lemur

Lemur catta

The diurnal ring-tailed lemur is found in dry brush, scrub and closed canopy forests of southern and southwestern Madagascar (Fig. 16), and is probably the most terrestrial and best-studied of all lemur taxa. It is also the lemur most commonly seen in zoos. It has a very distinctive gray coat on its body, arms and legs, white underparts, a white face with black muzzle and eye rings, and a characteristic black-and-white striped tail (Tattersall, 1982).

Based upon the revised taxonomy of Simons and Rumpler (1988), *Lemur catta* is now a monotypic genus. The northern limit of its range appears to be the forests south of Morondava on Madagascar's west coast (Sussman, 1977), and it is said to range into the interior highlands further than any other lemur (Tattersall, 1982). Long-term studies at the Berenty Private Reserve and Beza-Mahafaly Special Reserve show that ring-tailed lemurs feed on fruit, leaves, flowers, bark and sap from more than 30 plant species, but the mainstay of their diet is the kily tree, *Tamarindus indica*. Group sizes range from three to two dozen individuals, with a female-dominated social hierarchy (Jolly, 1966; Sussman, 1974).



Russell A. Mittermeier

The fork-marked dwarf lemur (*Phaner furcifer pallescens*), this one from the vicinity of Analabe, southwest Madagascar.

Recent satellite surveys of southern Madagascar indicate that *Lemur catta* habitat is disappearing at an alarming rate. This is due largely to fires, overgrazing by livestock and the cutting of trees to produce charcoal (Harocourt and Thornback, 1990). Ring-tailed lemurs are also hunted with dogs in some areas (O'Connor, 1987) and often kept as pets.

Lemur catta is found in the Isalo National Park, Tsimanampetotsa, Andohahela and Andringitra Nature Reserves, the Beza-Mahafaly Special Reserve and Berenty Private Reserve (Nicoll and Langrand, 1989). Surveys are needed to determine the distribution and sizes of remaining populations. Efforts should also be made to link captive breeding programs — there are probably more than 1,000 ring-tailed lemurs in over 100 zoos worldwide — with conservation programs in the field.



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The ring-tailed lemur (*Lemur catta*).

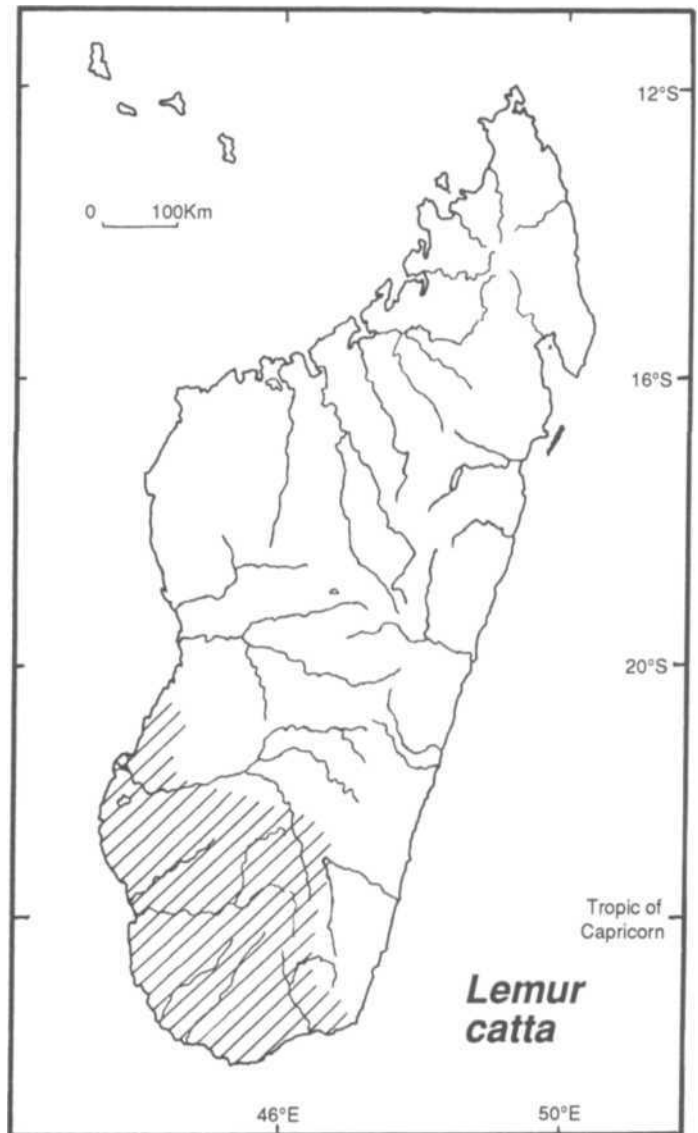


Figure 16. Distribution of the ring-tailed lemur (*Lemur catta*).

Black-and-White Ruffed Lemur

Varecia variegata variegata

The black-and-white ruffed lemur occurs in the eastern rain forest (Fig. 17), extending southward from the Antainambalana River (where its range meets that of *Varecia variegata rubra*) to just north of the Mananara River (Petter *et al.*, 1977; Tattersall, 1982; Petter and Petter-Rousseaux, 1979); it was also introduced to the island of Nosy Mangabe in the 1930s (Constable *et al.*, 1985). Considerable variation in the coat color and pattern of the black-and-white ruffed lemur suggests that several varieties, ranging from predominantly white to predominantly black in color, might be recognized as subspecies (Petter *et al.*, 1977; Tattersall, 1982).

Varecia variegata variegata appears to occur at low densities throughout its range, with the exception of the population on Nosy Mangabe (Pollock, 1984). It eats mostly fruit, supplemented with nectar, seeds and leaves (White, 1989; Simons Morland, in prep). Groups range in size between two and five individuals and they are very territorial (Petter *et al.*, 1977; Pollock, 1979; Jolly *et al.*, 1984). A great deal has been learned about the reproductive behavior of this species through studies of captive animals (Bogart *et al.*, 1977; Boskoff, 1977; Foerg, 1982).

Black-and-white ruffed lemurs are found in the Verezanant-soro, Mantady and Ranomafana National Parks, the Andringitra, Betampona and Zahamena Nature Reserves and in the Ambatovaky, Nosy Mangabe and Analamazaotra Special Reserves (Pollock, 1984; Nicoll and Langrand, 1989; Harcourt and Thornback, 1990; Thompson and Evans, 1991). Better protection of wildlife is needed in most of these areas, where local villagers commonly keep *Varecia* and other lemurs as pets.

Searches for *Varecia variegata variegata* should be conducted in the Mangerivola, Marotandrano and Tampoketsa-Analamaitso Special Reserves, and creation of a new protected area to the west or southwest of Maroantsetra should be considered. A survey is being conducted by Hilary Simons-Morland to identify distinguishable varieties of this species. Genetic studies are needed to clarify the status of these varieties, and long-term field studies of known populations should be carried out in several protected areas. A successful captive breeding program makes reintroduction a possibility, but this should take place only after the genetic questions have been answered (St. Catherine's Workshop, 1986).

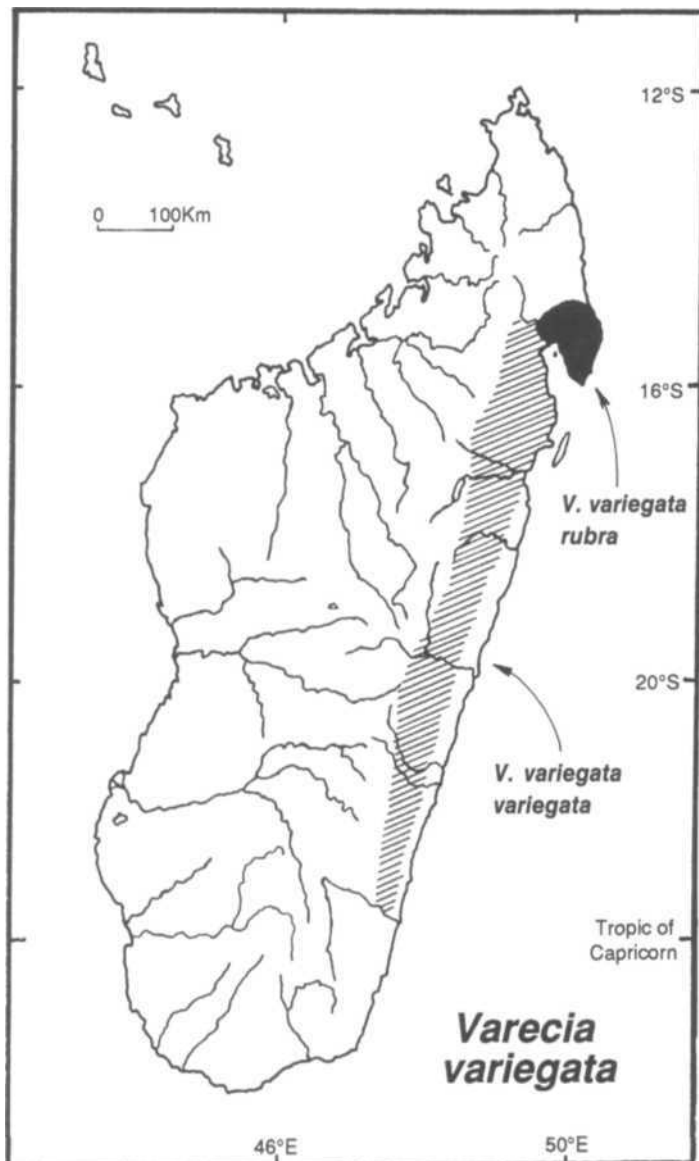
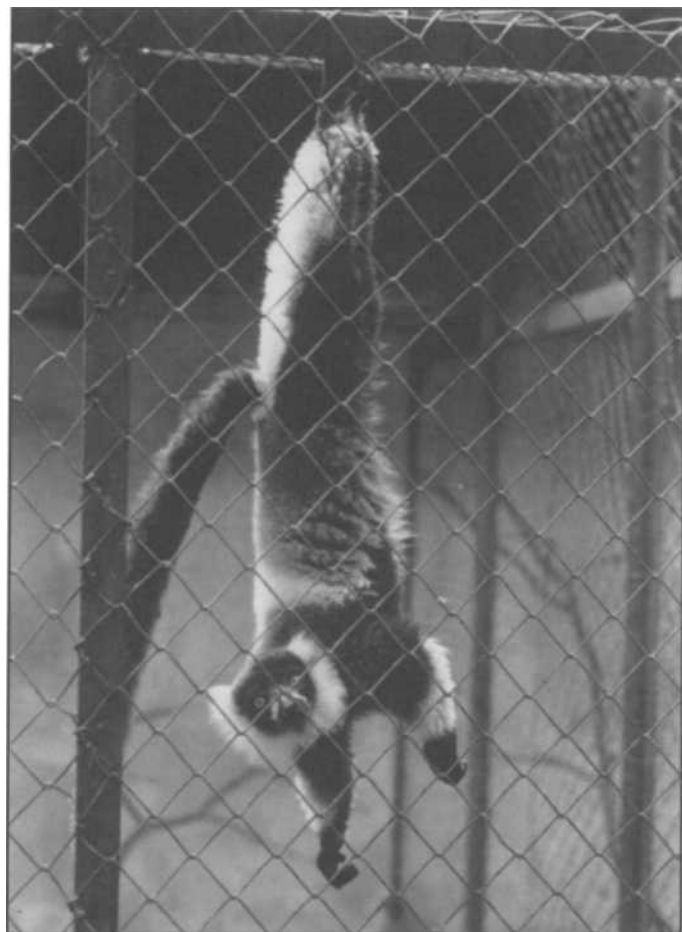


Figure 17. Distribution of ruffed lemurs (*Varecia variegata*).



Russell A. Mittermeier

Black-and-white ruffed lemur (*Varecia variegata variegata*).



William R. Konstant

A black-and-white ruffed lemur at Zoo Ivoloina, Madagascar, showing darker pattern of coloration on back and flanks.

Simpona or Diademed Sifaka

Propithecus diadema diadema

This is the most widely distributed of the *P. diadema* subspecies, and is found in the eastern rainforests (Fig. 18) from the Mangoro River in the south to near Maroantsera in the north (Petter *et al.*, 1977; Petter and Petter-Rousseaux, 1979; Tattersall, 1982). The diademed sifaka's hindquarters and hindlimbs are a light golden color; its tail, forelimbs, forehead, throat and cheeks are white; and its face crown and extremities are black (Tattersall, 1982).

Propithecus d. diadema is found in the Verezanantsoro and Mantady National Parks, the Betampona and Zahamena Nature Reserves and the Ambatovaky and Analamazaotra Special Reserves (Pollock, 1975, 1984; Simons, 1984; Raxworthy, 1986, 1988; Nicoll and Langrand, 1989; Katz, 1991; Thompson and Evans, 1991). It is threatened by habitat destruction due to agricultural encroachment and logging, and by hunting (Simons, 1984). There are currently no individuals in captivity.

All of the above-mentioned parks and reserves are in need of better protection, and studies of the diademed sifakas are necessary to determine population sizes, limits of its distribution and ecological requirements (Harcourt and Thornback, 1990). Searches for the diademed sifaka should be conducted in the Mangerivola, Marotandrano and Tampoketsa-Analamaitso Special Reserves and in the region southwest of Maroantsera, where a new special reserve is proposed. A captive breeding program should also be developed.



Diademed sifaka (*Propithecus diadema diadema*).



Milne-Edwards' sifaka (*Propithecus diadema edwardsi*) in the Ranomafana National Park.

Simpona or Milne-Edward's Sifaka

Propithecus diadema edwardsi

Milne-Edward's sifaka is reported to occur in the eastern rainforest (Fig. 18) southward from the Mangoro River to Manakara (Tattersall, 1982). Its color is almost entirely black or chocolate brown, with variable white patches on the back and flanks.

Studies of *P. d. edwardsi* have been conducted at Ranomafana National Park, where group size ranges from four to eight animals; no territorial behavior is displayed and the sifakas eat leaves, fruits and flowers (Wright *et al.*, 1987). This subspecies is also reported from the Andohahela Nature Reserve (O'Connor *et al.*, 1986, 1987), the Pic d'Ivohibe Special Reserve and the Midongy-Sud Classified Forest (Nicoll and Langrand, 1989). The primary threat to these and other populations is habitat destruction. There are none in captivity.

Surveys and better protection are needed for the protected areas listed above. Wright (1988) describes plans for increasing protection at Ranomafana National Park, where long-term studies should be continued. Searches for new populations should be conducted at the Andringitra Nature Reserve, which is very close to Pic d'Ivohibe. Genetic studies and fieldwork should be conducted to clarify the relationship with *P. d. holomelas*, and a captive breeding program should begin as soon as possible.

Coquerel's Sifaka

Propithecus verreauxi coquereli

Coquerel's sifaka inhabits deciduous and evergreen forests in northwestern Madagascar (Fig. 19), north of the Betsiboka River to Antsohihy and east to Antetemazy (Tattersall, 1982). Its color is white on the dorsal surface and maroon on the abdomen, inner thighs and forelimbs.

The average family group is four to five individuals; there is considerable overlap between home ranges and no evidence of territoriality (Petter, 1962; Richard, 1974; Albignac, 1981). Coquerel's sifaka eats leaves, buds, flowers, fruit and bark (Richard, 1974).

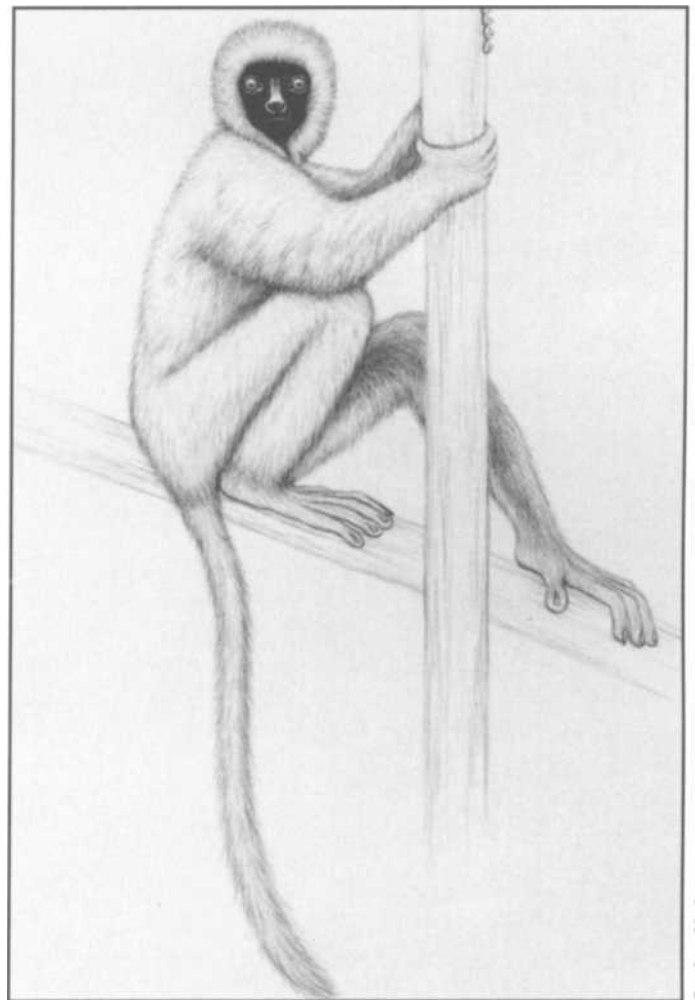
This animal is known to inhabit the Ankarafantsika Nature Reserve and may be present in the Bora Special Reserve as well, but habitat destruction within these protected areas is a major threat. Hunting is not yet a serious problem due to local taboos.

Increased protection is needed in both reserves in which *P. v. coquereli* appears to occur, as are surveys to determine its status elsewhere. Searches for other populations should be conducted in the Bongolava region between Ankarafantsika and Bora. The Duke University Primate Center maintains a small colony of this subspecies; this captive breeding program should be expanded.



Russell A. Mittermeier

Coquerel's sifaka (*Propithecus verreauxi coquereli*) at the Ampijoroa Station, Ankarafantsika Nature Reserve.



Stephen Nash

Decken's Sifaka

Propithecus verreauxi deckeni

Decken's sifaka is found in dry deciduous forest southwest of the Betsiboka River to near Antsalova (Tattersall, 1982), although there is some question about the boundaries of its range and that of *P. v. coronatus* (Figs. 12,19). Decken's sifaka is almost completely white in color (Harcourt and Thornback, 1990). There have been no studies of its behavior and ecology.

This animal is found in the Tsingy de Bemaraha and Namoroka Nature Reserves and is reportedly abundant in the Ambohijanahary Special Reserve (Nicoll and Langrand, 1989). The principal threat to its existence, even within these protected areas, is habitat destruction due to fires set annually to clear land for pasture.

All of the reserves mentioned above require better protection. Searches and surveys to confirm the existence of Decken's or crowned sifakas should be conducted in the Bemarivo, Maningoza and Kasijy Special Reserves, in the Lac Kinkony and Tsimembo Classified Forests, and in the region surrounding Soalala. Genetic research is necessary to clarify the relationship between *P. v. coronatus* and *P. v. deckeni*.

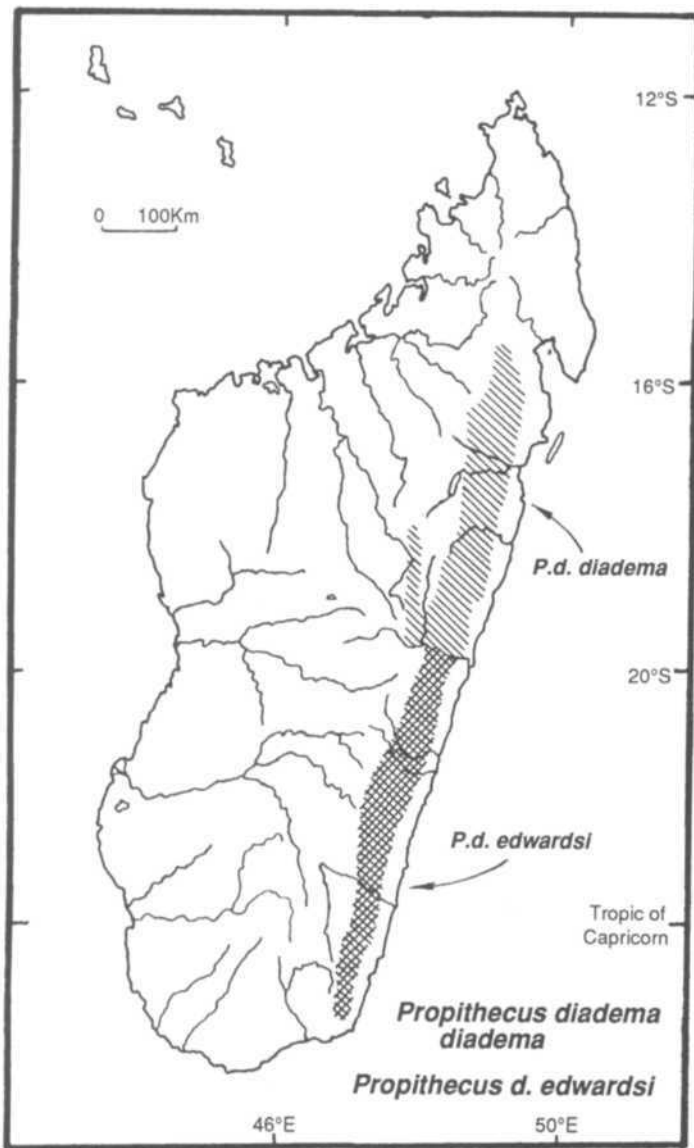


Figure 18. Distribution of *Propithecus diadema diadema* and *Propithecus diadema edwardsi*.

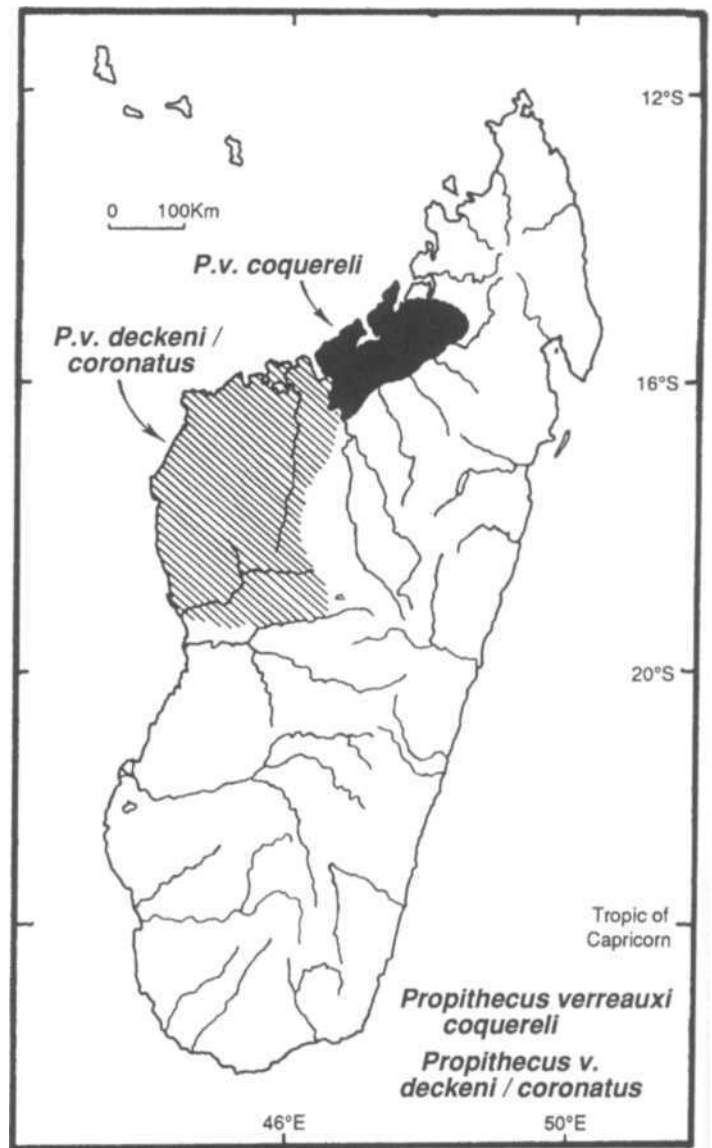


Figure 19. Distribution of *Propithecus verreauxi coquereli* and *Propithecus verreauxi deckeni*.

Crowned Lemur

Eulemur coronatus

The crowned lemur is diurnal and is found in dry and humid forests of northern Madagascar. Its range extends west as far as the Ankarana Massif and east to the Fanambana River (Fig. 20). Male crowned lemurs are brown with a black crown between the ears; females are gray with a light brown crown (Tattersall, 1982).

Population densities for this species vary considerably throughout its range (Arbelot-Tracqui, 1983; Fowler *et al.*, 1989; Wilson *et al.*, 1989; Hawkins *et al.*, in press). It is primarily frugivorous, leaves being taken only rarely. Typical groups number five or more individuals and do not appear to be territorial towards conspecifics. They do act aggressively, however, toward other lemur species (Wilson *et al.*, 1989).

Eulemur coronatus is reported from Montagne d'Ambre National Park and the Analamera, Ankarana and Forêt d'Ambre Special Reserves (Nicoll and Langrand, 1989), but it remains threatened within these protected areas due to brush fires, logging, grazing and hunting (Wilson *et al.*, 1988). A small number breed in captivity in European and North American zoos, as well as in Madagascar's Parc Tsimbazaza.

Better protection for crowned lemurs and other species is needed in Madagascar's northern reserves, as are surveys to determine their numbers and conservation status. The captive breeding effort for *Eulemur coronatus* should be expanded.

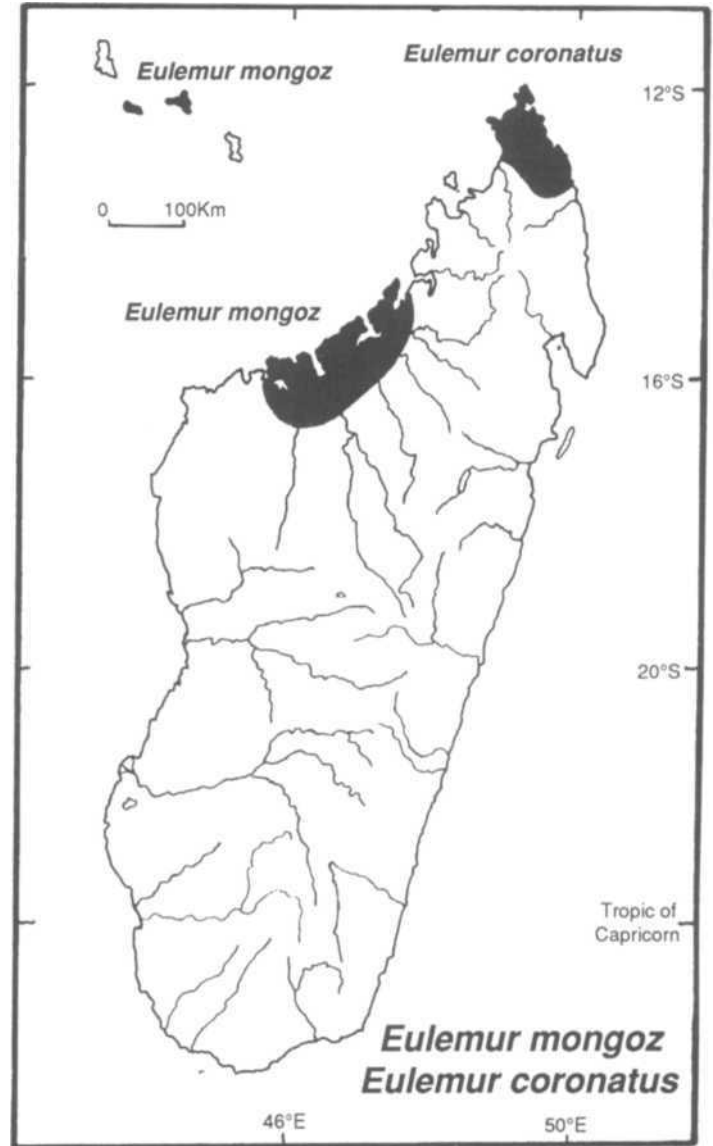


Figure 20. Distribution of crowned (*E. coronatus*) and mongoose lemurs (*E. mongoz*)

Mongoose Lemur

Eulemur mongoz

The precise limits of the mongoose lemur's range in western Madagascar remain to be determined (Fig. 20); it is also found in the Comores on the islands of Moheli and Anjouan, where it was probably introduced (Petter, 1977; Tattersall, 1976, 1982). The species is sexually dichromatic; females are grayish-brown with a dark face and white cheeks and beard, while males are gray with pale faces and reddish-brown cheeks and beard.

Both diurnal and nocturnal activity have been reported for this species (Tattersall and Sussman, 1975; Harrington, 1978). Mongoose lemurs are reported to eat flowers, fruit and leaves (Andriatsarafara, 1988) and to live in family groups averaging five individuals.

Eulemur mongoz is known to occur in only one protected area in Madagascar, the Ankarafantsika Nature Reserve, which is threatened by clearance for pastures and crops, and burning to



Female crowned lemur (*Eulemur coronatus*).

Russell A. Mittermeier



Mongoose lemur (*Eulemur mongoz*) family. Adult male on left and adult female at lower right.

produce charcoal (Nicoll and Langrand, 1989). In the Comores, although protected by law, mongoose lemurs are commonly captured for pets; habitat destruction by man and cyclones has also decreased the amount of forest habitat available to *Eulemur mongoz* (Tattersall, 1977, 1983). Captive colonies of mongoose lemurs exist in European and North American zoos. Particular success has been achieved at France's Mulhouse Zoo and at the Duke University Primare Center.

Better protection is needed for the lemurs of Ankarafantsika, the only reserve in which *Eulemur mongoz* is found. The creation of officially protected areas is probably necessary to safeguard this species in the Comores. An increased effort should be made to breed this species in captivity.

White-Collared Brown Lemur

Eulemur fulvus albocollaris

The brown lemur, *Eulemur fulvus*, is the most widespread of Madagascar's diurnal lemurs and is represented by six subspecies. The white-collared brown lemur (*Eulemur f. albocollaris*) appears to have a limited distribution between the Mananara and Faraony Rivers in southeastern Madagascar (Fig. 21). It is a rich brown-colored lemur with a white or orange beard (Tattersall, 1982).

No detailed studies have been conducted on this subspecies to date. The only protected area in which it is known to occur is the Manombo Special Reserve (Nicoll and Langrand, 1989; S. Goodman and T. Schulenberg, pers. comm.), where it is common in both parcels but hunted throughout. The reserve itself suffers from deforestation for fuel wood production. Only a few white-collared brown lemurs are found in captivity.

A survey of the Manombo Reserve is needed (St. Catherine's Workshop, 1986), and it will likely require better protection. A captive breeding program should begin as soon as possible.

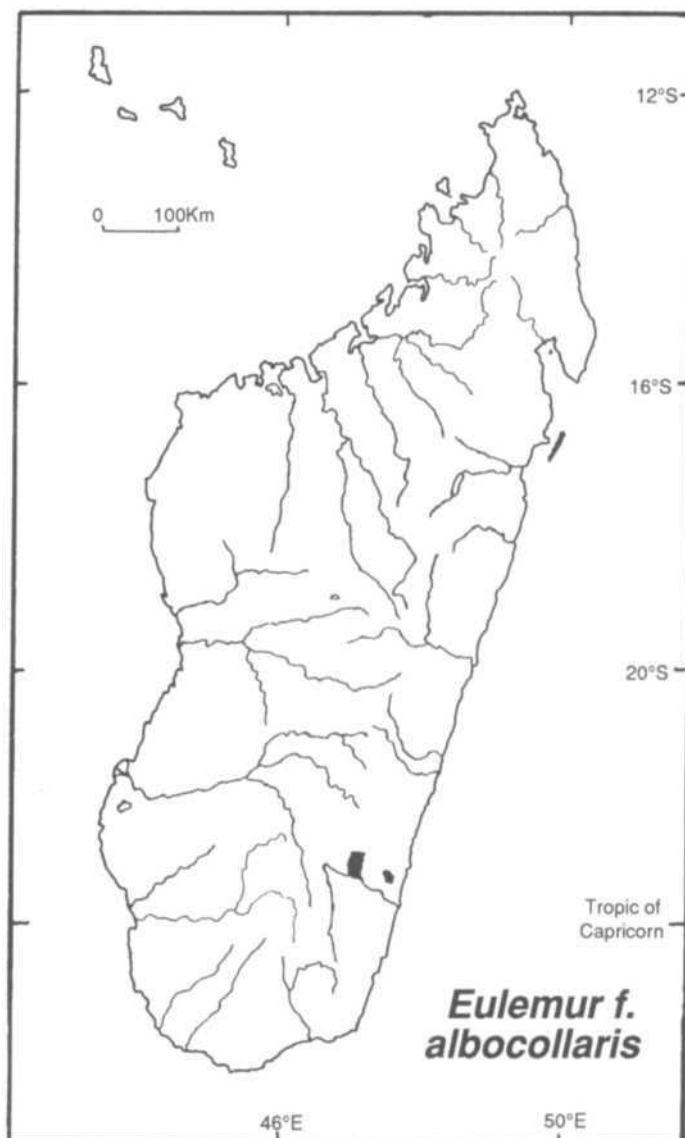


Figure 21. Distribution of *Eulemur fulvus albocollaris*.



White-collared brown lemur (*Eulemur fulvus albocollaris*).

Mayotte Brown Lemur
Eulemur fulvus mayottensis

This subspecies is found in secondary forest, the only forest remaining on the island of Mayotte in the Comores (Fig. 22), and may be the result of the introduction of *Eulemur f. fulvus* several hundred years ago (Tattersall, 1977). The Mayotte lemur eats mainly fruit, leaves and flowers, and appears to live in loosely associated groups averaging nine to ten individuals.

Tattersall (1983, 1989) has reported an accelerating decline in the numbers of lemurs on Mayotte and an increasing exploitation of their habitat. He estimated that the population stood at 50,000 in 1975 but, due to uncontrolled development in the 1980s, it is very likely to be half that number today. Although lemurs are sometimes hunted, this is less a threat. Unfortunately, no protected areas exist on Mayotte (Harcourt and Thornback, 1990). A significant captive population exists in North American and European institutions (Wilde *et al.*, 1988).

A study should be undertaken to determine whether the Mayotte lemur is genetically distinct from *Eulemur f. fulvus*. In any case, a protected area of some kind should be established on Mayotte to protect this Comores lemur population. Efforts to breed it in captivity should continue.



Ian Tattersall

Mayotte Brown Lemur (*Eulemur fulvus mayottensis*).



Figure 22. Distribution of *Eulemur fulvus mayottensis* and *Hapalemur griseus occidentalis*.



Stephen Nash

Western gentle lemur (*Hapalemur griseus occidentalis*).

Western Gentle Lemur

Haplemur griseus occidentalis

The western gentle lemur is a slightly smaller animal, rarer and more sparsely distributed than the nominate subspecies. It is gray-brown in color and occurs in several isolated populations in western Madagascar (Fig. 22) near Lake Bemamba and in the Sambirano region (Petter and Andriatsarafara, 1987). There are also recent reports of its occurrence in the Ankarana Special Reserve in northwest Madagascar (Hawkins *et al.*, in press). There are apparently no western gentle lemurs in captivity.

Haplemur griseus occidentalis is a diurnal lemur living in groups of up to four individuals, and appears to be confined to forests that contain bamboo (Tattersall, 1982). It is threatened primarily by destruction of its forest habitat, in the form of fires set to promote grass growth for livestock grazing.

This subspecies is found in three protected areas: the Tsingy de Bemaraha Nature Reserve and the Ankarana and Manongarivo Special Reserves. Surveys are needed to determine the size and status of its populations in these three reserves, as are searches for new populations in surrounding areas.

Avahi or Woolly Lemur

Avahi laniger

The avahi is a small, nocturnal, folivorous lemur. There are two subspecies, *Avahi l. laniger*, widely distributed in the eastern rainforests, and *A. l. occidentalis*, with a more restricted distribution in northwestern Madagascar (Fig. 23) (Tattersall, 1982). *Avahi* is the smallest member of the family Indridae, averaging about 1 kg in weight, and is grayish-brown in color. Although there have been no long-term studies of this species, it is reported to be monogamous, adult females giving birth to one young each year. Woolly lemurs are also reported to be territorial; family groups of 3-5 animals aggressively defend home ranges of 1-2 hectares.

Avahi l. laniger was originally reported to occur from the latitude of Sambava in the north to that of Fort Dauphin in the south (Petter *et al.*, 1977; Petter and Petter-Rousseaux, 1979; Tattersall, 1982). The other protected areas in which it can be found include: the Mantady and Ranomafana National Parks; the Andohahela, Andringitra, Betampona, Marojejy and Zahamena Nature Reserves; and the Ambatovaky, Ambohitante-

ly, Analamazaotra and Anjanaharibe-Sud Special Reserves (Pollock, 1984; Simons, 1984; O'Connor *et al.*, 1986; Raxworthy, 1986; Nicoll and Langrand, 1989; Safford *et al.*, 1989; Thompson and Evans, 1991). The major threat to the eastern avahi is habitat destruction for timber and agricultural land.

The western avahi (*A. l. occidentalis*) appears to have a disjunct distribution north and east of the Betsiboka River. It has been reported from the Ankarafantsika and Tsingy de Bemaraha Nature Reserves and the Manongarivo Special Reserve (Raxworthy and Rakotondrapary, 1988; Thalmann, 1990). It is not clear which subspecies of *A. laniger* occurs in the Ankarana Special Reserve (Fowler *et al.*, 1989; Hawkins *et al.*, in press). The principal threat to this and other lemur species in these protected areas is habitat destruction due to fires set to promote growth of new grass.

Better protection is needed for all of the national parks and reserves listed above. A management plan for the Ankarafantsika Nature Reserve is being developed with financial assistance from the World Bank (Nicoll and Langrand, 1989). Creation of a new protected area on the Masoala Peninsula would help safeguard populations of *Avahi l. laniger*. There are no *Avahi* in captivity, and no recommendations to establish a captive breeding program at this time.

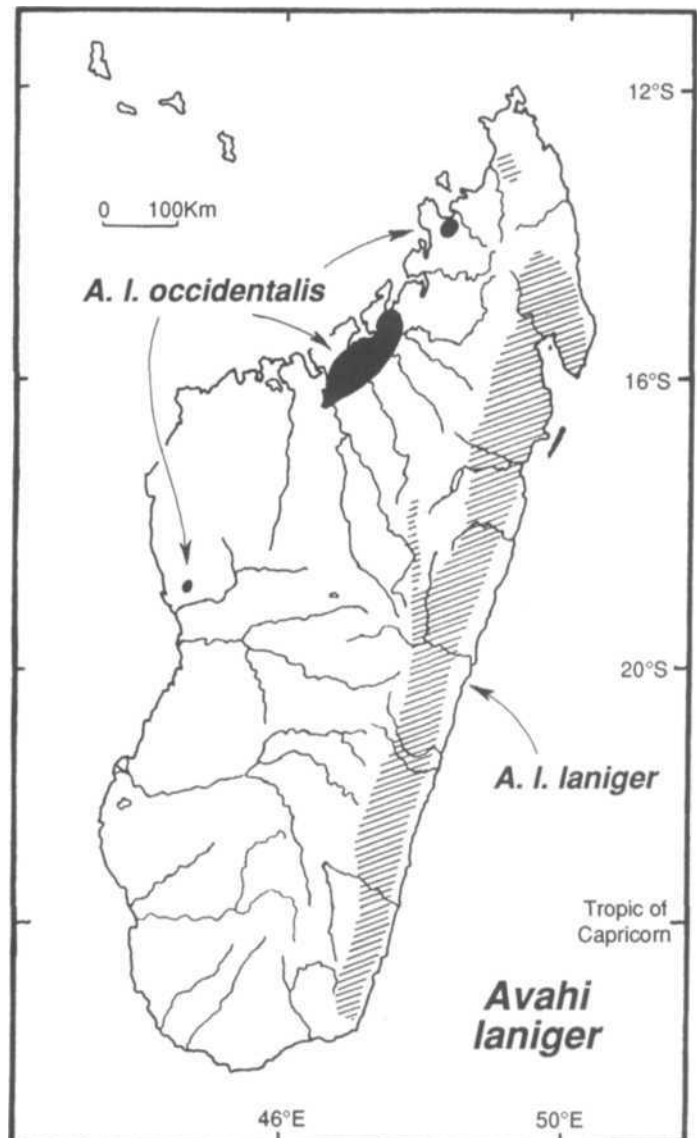


Figure 23. Distribution of *Avahi laniger*.



Eastern avahi (*Avahi laniger laniger*) photographed in the Zahamena Nature Reserve.

Chris Raxworthy

Section 5: Conservation Priorities for Madagascar Lemurs

This section of the Action Plan identifies priority projects and long-term programs for lemur conservation during the 1990s as they relate to the existing system of protected areas in Madagascar. Immediate action is required to ensure the survival of endangered lemurs throughout Madagascar, but primarily in the eastern forests. The projects recommended here fall within several broad categories of action, according to accepted strategies for the conservation of highly endangered primates (Mittermeier, 1986) and have been presented with serious consideration given to logistics and the realities of fieldwork in Madagascar. We have tried to maximize the efficiency of proposed conservation actions by focusing on large communities of the most threatened lemur species and by proposing a number of projects that involve multiple protected areas in close proximity.

In general, the following types of activities are recommended by this Action Plan:

1. Locating Remaining Populations of Endangered Primates and Determining Basic Geographic Distribution

We still know remarkably little about wild populations of even some of the best known lemur species. Thus, survey work of the most basic kind is required throughout Madagascar, and especially for those lemur species of high conservation priority. In carrying out these surveys, particular attention must be paid to the status of populations within existing protected areas, since these are the places in which the species will be most likely to survive. In addition, investigations of lemur populations should be made in areas identified as sites of biological importance, for which there is currently no official protection. The confirmed presence of significant populations of endangered lemurs in such areas can be used as a conservation tool to help increase protection.

2. Conducting Ecological, Behavioral and Genetic Studies to Determine the Basic Requirements of the Species

Wherever possible, scientific studies of lemur populations should be developed to identify the threats to these populations and to determine whether they are likely to be viable over the long term. The eventual goal of such studies is to develop management plans to ensure the survival of species and habitat. In addition, a continuing scientific presence has great conservation value as a deterrent against poaching and habitat encroachment.

3. Improving Protection in Existing Parks and Reserves

According to Nicoll and Langrand (1989), most parks and reserves within Madagascar's system of protected areas are inadequately protected. In general, most require management plans, additional staff, increased budgets, housing and operational facilities, equipment, professional training for staff, and public education programs to involve the surrounding communities. Many of the recommendations offered by Nicoll and Langrand (1989) remain to be implemented. Specific projects

described in this Action Plan focus on creating facilities, increasing the available manpower and building the capacity of governmental and non-governmental conservation agencies in Madagascar. It is also important to recognize the contribution being made to lemur conservation by privately protected reserves.

4. Establishing New Protected Areas

Establishment of new protected areas is especially important if none currently exist within the range of endangered species, or if existing protected areas are inadequate to ensure species' survival. Creation of new parks and reserves is a time-consuming and expensive process, and one that must be based upon sound scientific information provided by basic survey work and long-term field research. Several endangered lemur species and subspecies are not found in any officially protected areas at this time, and the prospects for their survival remain poor until such areas are created.

5. Increasing Public Awareness of the Importance of Wildlife

Lemurs stand out clearly as symbols for conservation in Madagascar and internationally. Without the support of the local people, field conservation programs on behalf of endangered species are not likely to succeed. Education programs and public awareness campaigns should be an integral part of the total conservation effort.

6. Creating Economic Incentives for Local Communities and Opportunities to Cooperate

Public awareness and environmental education programs may help change people's attitudes toward lemurs and other wildlife, primarily in areas where populations are literate and have access to public media. However, interactive conservation and development programs are also necessary to demonstrate that there are economic incentives to local communities directly related to the protection and wise use of tropical forest habitat and wildlife populations. Grass roots efforts of this nature need to be a part of the management plans for all reserves within Madagascar's system of protected area system.

7. Training Nationals

Training of Malagasy students and researchers is essential for the long-term future of lemurs and other wildlife. Conservation-oriented training of promising young students should be a high priority and should range from local training of guards and park wardens to college and masters level programs at Malagasy universities and Ph.D.-level programs abroad.

8. Developing Captive Breeding Programs

Based upon the size and status of remaining wild populations, captive breeding programs may be necessary to ensure the survival of endangered lemur species. This will involve both foreign programs developed by zoological institutions in the United States and Europe, and in-country efforts in Madagascar.

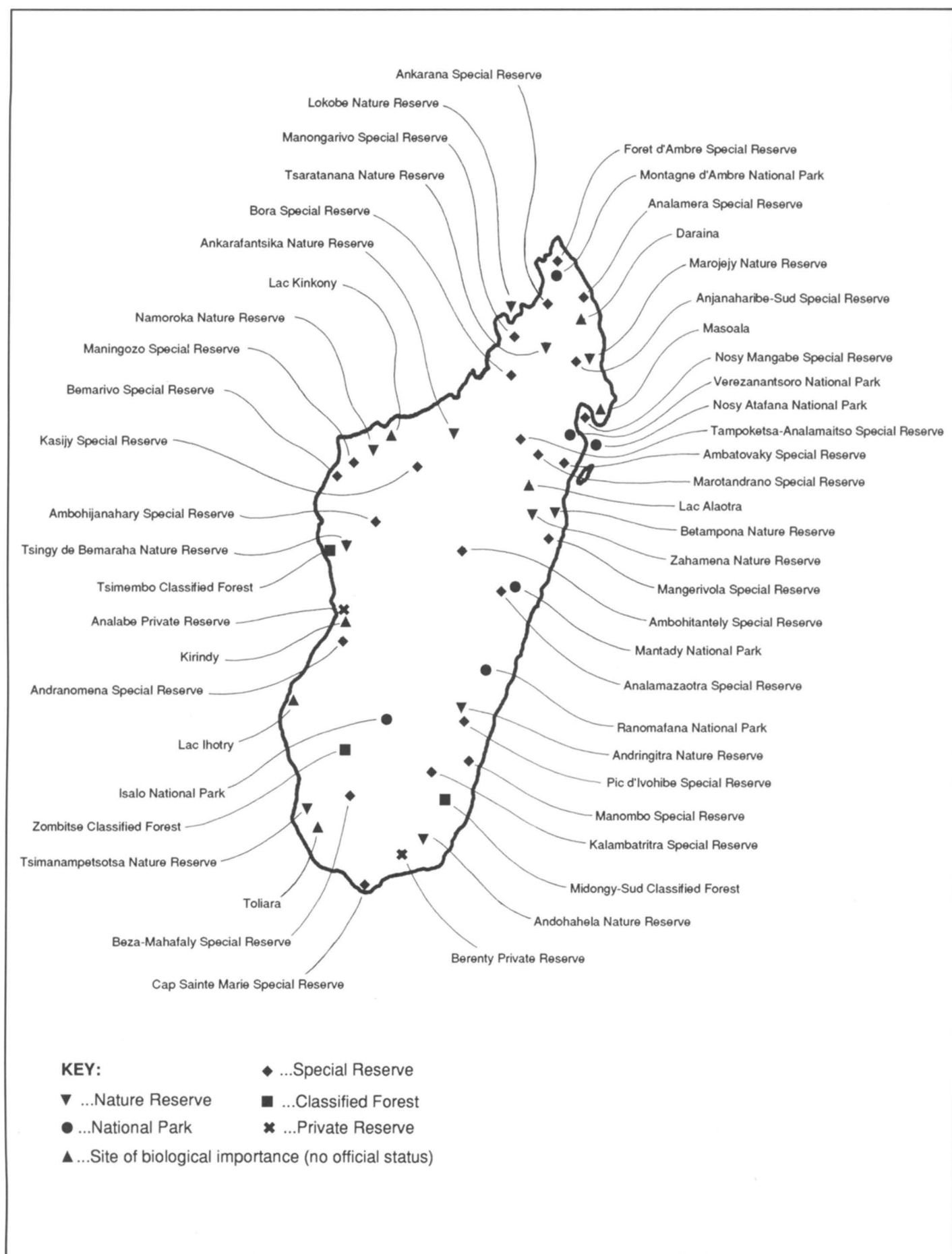


Figure 24. Protected areas and other sites of biological importance in Madagascar.

Recommendations by Region, Protected Area and Lemur Communities

Recommendations for lemur conservation programs and projects are organized according to the major biogeographic regions identified in the preceding sections (Fig. 1). The species-oriented projects for each region include surveys within existing protected areas and other sites of biological importance (Fig. 24), and searches for new populations in areas which currently receive no protection.

In an effort to estimate the costs of conducting such projects, we have used simple formulas. For surveys and censuses, \$10,000—\$15,000 has been budgeted for each year of fieldwork projected, understanding that the collection of data from large and inaccessible areas will require larger and better equipped survey teams working for longer periods of time. Consideration is also given to the need for foreign expertise and the resultant international transportation costs. Should research also be recommended to solve existing taxonomic problems, \$10,000—\$15,000 has been budgeted to cover the cost of fieldwork and requisite laboratory analyses. An additional \$10,000/year is estimated for each year of long-term field research on lemur ecology, behavior and conservation status.

It is a bit more difficult to estimate the full costs of increasing protection for the existing parks and reserves, developing community-based public awareness campaigns, creating economic incentives for local communities and establishing new protected areas. Lemur conservation is one component of such efforts, and it would be misleading to assign the costs of creating, developing and managing protected areas or changing public attitudes toward conservation to the needs of a single lemur species or even entire lemur communities. We have focused on an element essential to all these programs: the establishment of permanent field stations within protected areas to base staff, conduct scientific research and provide for visitation. We have estimated the construction and equipment costs at \$50,000 and maintenance cost of each fully equipped field station at \$10,000/year.

Environment Program 1 (EP1) is the first five-year phase of an international effort to support the implementation of Madagascar's National Environmental Action Plan (NEAP), a fifteen to twenty-year program. Under one of EP1's seven components, biodiversity conservation, large sums of money are being allocated to develop a number of Madagascar's parks and reserves, programs that will ultimately safeguard a number of important lemur populations. EP1 targets 50 protected areas and is being funded by United States Assistance for International Development (USAID), United Nations Development Program (UNDP), Direction de la Coopération Suisse au Développement et à l'Aide Humanitaire (DDA: Swiss Cooperation), Kreditanstalt für Wiederaufbau (KfW: German Financial Cooperation), the Royal Government of Norway (NORAD) and the World Bank (IDA). Implementing agencies include Madagascar's Ministry of Water and Forests (MEF), the National Association for the Management of Protected Areas (ANGAP), the World Wide Fund for Nature (WWF), United Nations Education, Scientific and Cultural Organization (UNESCO), Missouri Botanical Gardens (MBG), Intercooperation Suisse, Duke University, SAFAFI (a Malagasy NGO) and Conservation International (CI). Under the NEAP, a total of 50 protected areas will be developed and funded (Greve, 1991; A. Greve, pers. comm.).

For the purposes of this Action Plan, we support recommendations of earlier documents for upgrading the level of protection currently available to Madagascar's parks and reserves, and the need to create new reserves in areas important for lemur conservation (Nicoll and Langrand, 1990; Stuart *et al.*, 1990). Where large-scale funding for protected area development and management has been allocated under the auspices of EP1, we strongly recommend that lemur conservation projects as presented in this document be included in the scope and funding priorities of the more comprehensive programs.

Eastern Region Eastern Domain

Mananara-Nord Biosphere Reserve (Verezanantsoro and Nosy Atafana National Parks)

The 140,000 ha Mananara-Nord Biosphere Reserve was created in 1989 as part of UNESCO's Man and the Biosphere Program. The project is financed by the United Nations Development Program and the World Bank. The biosphere reserve includes two national parks: Verezanantsoro (23,000 ha) and Atafana (1,200 ha), a marine park, and a 115,000 ha multiple-use area (Greve, 1991). It is bordered by the Mananara River to the north; the Mananara, Sandrakatsy and Fotsialanara rivers to the west; the Anove River to the south and the Indian Ocean to the east (Albignac, 1988).

The forests of Mananara-Nord reportedly harbor populations of *Daubentonia madagascariensis*, *Allocebus trichotis*, *Indri indri*, *Propithecus d. diadema* and *Varecia variegata variegata*, making its development and protection one of the highest priorities for lemur conservation in Madagascar. Threats to the reserve include slash-and-burn clearance for rice cultivation, cutting of timber for construction and hunting of lemurs and other wildlife for food. About 40,000 people live within the reserve's multiple-use area (Albignac, 1988).

The goals of the UNESCO project are to counteract the traditional practice of *tavy* (slash and burn agriculture). In exchange for agreeing not to extend this practice, local populations will be provided with services such as schools or clinics, or will be assisted in acquiring and implementing new agricultural techniques, especially for rice production. Since this project began, a decline in forest destruction has been observed (Greve, 1991).

Surveys are needed to assess the status of Mananara-Nord's lemur populations, as are long-term ecological studies, especially for populations of the five species listed above. As part of the overall effort to manage this new protected area, a field station is to be constructed, and research and public awareness programs are soon to be initiated.

Ambatovaky Special Reserve

The Ambatovaky Special Reserve represents a considerable tract of protected forest in Madagascar's Eastern Domain; 51,050 ha of its total 60,050 ha falls within this phytogeographical category. Analyses of satellite photographs indicate that large tracts of lowland forest remain within its boundaries (Nicoll and Langrand, 1990). Several species of high conservation priority have been found in Ambatovaky, including *Daubentonia madagascariensis*, *Indri indri*, *Propithecus d. diadema*, *Varecia variegata variegata* and *Avahi laniger* (Thompson and Evans, 1991).

Surveys will be needed to document the size of lemur populations in this large area and the status of the remaining forests, and they should commence as soon as funds become available. General recommendations regarding protection of Ambatovaky include increasing the guard staff (Nicoll and Langrand, 1989) and establishing a field station as a base of operations for reserve management and scientific research. The need for a public awareness program remains to be determined. Increased protection for Ambatovaky is not yet provided under EP1.

New Protected Area on the Masoala Peninsula

The Masoala Nature Reserve was created in 1927 on the north-eastern part of the Masoala peninsula, but was declassified in 1964 to permit timbering. A 300,000 ha national park has been proposed for this area (Nicoll and Langrand, 1989; Stuart and Adams, 1990). Nine lemur species are reported from the Masoala Peninsula, including *Microcebus rufus*, *Cheirogaleus medius*, *Hapalemur griseus*, *Lepilemur* sp., *Eulemur fulvus albifrons*, *Phanerfurfifer*, *Avahi l. laniger*, *Varecia variegata rubra* and *Daubentonia madagascariensis* (Nicoll and Langrand, 1989). Of these, the last four are priority taxa, especially *Varecia variegata rubra* which does not occur in any officially protected area at present.

Threats to the Masoala's forests and wildlife include the cutting of timber for construction, slash-and-burn cultivation to clear land for rice, vanilla, coffee, cloves and palms, and the hunting and trapping of wildlife (Constable *et al.* 1985; Simons and Lindsay, 1987; Nicoll and Langrand, 1989). *Eulemur fulvus albifrons* and *Varecia variegata rubra* appear to be most susceptible to trapping. There are currently no management or research facilities within the proposed national park. Responsibility for management is with the regional foresters association.

A botanical survey of the Masoala Peninsula has already been undertaken by the Parc Botanique et Zoologique de Tsimbazaza, the University of Madagascar, Kew Gardens and the Missouri Botanical Gardens. Surveys of the lemur fauna are urgently needed, especially of *Varecia variegata rubra* and *Daubentonia madagascariensis*. Development of the Masoala Peninsula National Park will be funded by USAID and other sources, and is to be implemented by the Missouri Botanical Garden and SAFARI under the auspices of EP1 (Greve, 1991). Plans include provision for properly trained and equipped staff, management and research facilities, and public awareness and education programs (Nicoll and Langrand, 1989).

New Protected Area near Maroantsetra

Due to the high species diversity in Madagascar's northeastern rainforests (Pollock, 1985), and the lack of protected areas in the region surrounding the Bay of Antongil, the recommendation has been made to establish one or more large reserves in the forests to the north and west of the town of Maroantsetra (Stuart *et al.*, 1990). Primate surveys in this region report evidence of at least eight lemur species: *Cheirogaleus major*, *Hapalemur griseus*, *Lepilemur mustelinus*, *Eulemur fulvus albifrons*, *Avahi l. laniger*, *Varecia variegata*, *Indri indri* and *Daubentonia madagascariensis* (Simons and Lindsay, 1986; Albignac, 1987; Raxworthy and Stephenson, 1988). It is also likely that these forests harbor populations of *Propithecus diadema candidus* and possibly *Allocebus trichotis*.

Surveys are needed to establish the distribution and status of the more endangered lemur species in this region as a prerequisite to proposing a new protected area.

Betampona Nature Reserve and Mangerivola Special Reserve

The 2,228 ha Betampona Nature Reserve is located 40 km northwest of the city of Tamatave in Toamasina Province. Like the Zahamena Nature Reserve, it is reported to harbor 11 lemur species, including *Daubentonia madagascariensis*, *Propithecus d. diadema*, *Indri indri*, *Varecia variegata variegata*, *Phanerfurfifer* and *Avahi l. laniger* (Jenkins, 1987; Katz, 1990). The reserve is surrounded by numerous villages, and several decades of exploitation have reduced its forest cover to 1,000 ha or less. Tavy cultivation, livestock grazing and lemur hunting are all known to occur along the boundaries. There is no field station at the reserve itself; personnel are based in the village of Fontsimavo, about 90-minute distant by foot (Pollock, 1985; Jenkins, 1987). Under EP1, the Church of Wales, U.K. is funding and implementing the development of the Betampona Nature Reserve (Greve, 1991).

Very little information is available about the 11,900 ha Mangerivola Special Reserve, but due to its proximity to the Betampona and Zahamena Nature Reserves, it may harbor significant populations of several important lemur species. Given their small size and close proximity, the Betampona and Mangerivola reserves should probably be studied and managed jointly. Faunal surveys are already underway at Betampona, supported by Duke University, Wildlife Preservation Trust International and Conservation International. These should be expanded to include Mangerivola. Long-term studies of the five lemur species listed above should begin at Betampona, as should construction of a field station, and the training and outfitting of personnel. The local public awareness program should be expanded.

Manombo Special Reserve

The 5,020 ha Manombo Special Reserve is a small tract of lowland rainforest on Madagascar's southeastern coast, about 30 km south of the city of Farafangana. Six lemur species are reported to occur here, including three of high conservation priority, *Daubentonia madagascariensis*, *Eulemur fulvus albocollaris* and *Avahi l. laniger*. Manombo is presently the only protected area in which this subspecies of brown lemur is thought to occur (Harcourt and Thornback, 1990).

Unfortunately, the reserve has been deforested by about 40% by the local people to provide timber for construction, to clear land to plant manioc, rice and coffee, and to create pasture for zebu cattle (Nicoll and Langrand, 1989). It is also common practice to hunt the diurnal lemurs. Although an adequate staff exists, it is based in the town of Farafangana, too far from the reserve to patrol it properly.

A survey is needed to determine the extent to which aye-aye and brown lemurs still occur in Manombo. A long-term ecological study of the brown lemur should also be initiated. A field station should be built closer to the reserve, from which an anti-poaching campaign can be mounted.

Nosy Mangabe Special Reserve

The 520 ha Nosy Mangabe Special Reserve consists of the entire island of Nosy Mangabe, 5 km from Madagascar's east

coast in the Bay of Antongil. Five lemur species occur here, including *Varecia v. variegata* (introduced in the 1930s; recently studied by H. Simons-Morland) and *Daubentonia madagascariensis* (introduced in 1966; recently studied by E. Sterling). A permanent field station has been constructed as a base of operations for researchers and the reserve guards, and a modest capacity for ecotourism is being developed. Long-term studies are needed on Nosy Mangabe to determine the viability of small populations in limited habitat, and the effects of ecotourism.

Central Domain

Zahamena Nature Reserve

Approximately 5,000 ha of the 73,160 ha Zahamena Nature Reserve is lowland tropical forest of the Eastern Domain; the remainder falls within the Central Domain. The reserve is located east of Ambatondrazaka in Toamasina Province, bordered to the south by the Onibe River, to the east by the Ihofika River, to the west by the Vohimahery River and to the north by the road from Sahatavy to Imerimandroso (Jenkins, 1987). Zahamena is situated 20 km to the east of Lac Alaotra and about 80 km west of the Indian Ocean. There are about 10 villages and a population of more than 2,000 people within the reserve's central enclave, the largest village being Andapa (Raxworthy, 1986; Nicoll and Langrand, 1990; Daniels, 1991). Access to the reserve is by foot, a two-day walk from the nearest road.

Eleven lemur species are known to inhabit Zahamena, including *Daubentonia madagascariensis*, *Indri indri*, *Propithecus d. diadema*, *Varecia variegata variegata*, *Avahi l. laniger* (Jenkins, 1987; Nicoll and Langrand, 1989) and *Phanerfurfifer* (Daniels, 1991). Faunal surveys of the reserve have been undertaken by the International Council for Bird Preservation and London University (Thompson *et al.*, 1987) and more recently by Conservation International. Threats to Zahamena include burning to clear land for agriculture and pasture, cutting of timber for construction and hunting of lemurs and other wildlife for food. The current staff is too small and insufficiently equipped to protect the reserve. There are currently no management facilities within the reserve (Nicoll and Langrand, 1990), but a management plan is being designed by Conservation International (Greve, 1991).

More complete surveys of Zahamena's lemur fauna are needed, as are long-term studies of the five species listed above. One or more field stations are needed to house staff, researchers and visitors, and from which to conduct a public awareness and environmental education program.

Ranomafana National Park

Ranomafana National Park was inaugurated in May 1991 and is composed of three parts covering a total of 41,600 ha (Greve, 1991). It is the only protected area in Madagascar where the critically endangered *Hapalemur aureus* and *Hapalemur simus* are known to occur (Meier and Rumpler, 1987). In all, 11 lemur species have been reported from Ranomafana, including populations of *Daubentonia madagascariensis*, *Varecia variegata variegata*, *Propithecus diadema edwardsi* and *Avahi l. laniger*. Surveys of all lemur populations have now been completed, providing reliable estimates for population sizes within the boun-

daries of this new protected area (Wright *et al.*, 1987; Wright, pers. comm.).

Funding for the continued development of Ranomafana National Park is provided by USAID and other agencies. Duke University is responsible for implementing development of the park and has already established a research station there (Harcourt and Thornback, 1990; Greve, 1991).

Surveys of other forests in this region are needed to determine whether species such as *Hapalemur aureus* and *Hapalemur simus* survive elsewhere (Meier and Rumpler, 1987; Fowler *et al.*, 1989; Wilson *et al.*, 1989).

Marojejy Nature Reserve and Anjanaharibe-Sud Special Reserve

The Marojejy Nature Reserve's 60,150 ha and Anjanaharibe-Sud Special Reserve's 32,100 ha both include forests of the Eastern, Central and High Mountain Domains. Due to their proximity, we recommend that these reserves be treated as a single unit in terms of research and management. Between them, Marojejy and Anjanaharibe-Sud contain 10 lemur species, including four taxa of high conservation priority: *Propithecus diadema candidus* (reported from both), *Daubentonia madagascariensis* (from Marojejy), *Indri indri* and *Avahi l. laniger* (from Anjanaharibe-Sud). This is the most important area for the survival of *Propithecus diadema candidus*.

Several years of survey work will be required to determine the distribution and population sizes of these endangered lemurs throughout the two reserves. Better protection of these two reserves is also needed, as they are very large and difficult to patrol. More guards are necessary and they must be better equipped. Field stations should be constructed at both Marojejy and Anjanaharibe-Sud, and a public awareness and environmental education program launched in the city of Andapa, which lies between them. According to Nicoll and Langrand (1989), these activities have been planned by the World Wide Fund for Nature. Funding for the reserves' development is being provided by the German Financial Cooperation (Greve, 1991).

Andohahela Nature Reserve

The 63,100 ha Andohahela Nature Reserve represents the southernmost extent of Central and Eastern Domain forests in Madagascar, and also contains a small tract of Southern Domain forest. It is one of the most interesting of all Madagascar's protected areas in terms of biological diversity (O'Connor *et al.*, 1986, 1987).

Fourteen species of lemur are known to occur in Andohahela, making it the richest protected area in Madagascar in terms of lemur diversity. The highest conservation priorities among the species reported from Andohahela include *Daubentonia madagascariensis*, *Lemur catta*, *Phanerfurfifer* and *Avahi l. laniger*. The conservation status within Andohahela for each of these taxa remains to be determined.

The Andohahela Protected Areas Management Program began in 1990 under the direction of the World Wide Fund for Nature and SAFAFI, with funding provided by US foundations and the Government of Madagascar. As a result, local conservation officers have been hired and trained, new trails have been cut, and reforestation, agricultural extension and environmental education efforts have begun (Greve, 1991).

New Protected Area near Daraina

Based upon the recent discovery of Tattersall's sifaka (*Propithecus tattersalli*), the recommendation has been put forth to create a 20,000 ha national park in the vicinity of Daraina in northern Madagascar (Meyers and Ratsirason, 1989; Harcourt and Thornback, 1990). This species currently is not found in any protected area. Recent surveys indicate that *Propithecus tattersalli* inhabits an area approximately 1,500 km² in size but that this area is less than 20% forested. Its distribution is patchy and there appears to be no means of genetic exchange between isolated populations, the largest of which is approximately 4,000. Total population of this species, although originally estimated in the hundreds upon its discovery, is probably close to 8,000 (D. Meyers, pers. comm.).

A long-term study and scientific presence is needed in this region as plans for a protected area are developed. Recent surveys have also observed *Daubentonia madagascariensis* and *Phanerfurfifer* (D. Meyers, pers. comm.) making this one of the very highest lemur conservation priorities in the entire country.

Montagne d'Ambre National Park and Foret d'Ambre Special Reserve

Located in close proximity to one another in northern Madagascar, these two protected areas cover approximately 23,000 ha and share seven lemur species, including three which are considered conservation priorities: *Daubentonia madagascariensis*, *Phanerfurfifer electromontis* and *Eulemur coronatus*. B. Freed of Washington University has undertaken a long-term field study of *E. f. sanfordi* and *E. coronatus*, but surveys are needed to determine distribution and population sizes of other lemurs within the reserves.

Management of Montagne d'Ambre National Park and the Foret d'Ambre Special Reserve is linked to a larger program which includes the Ankarana and Analamera Special Reserves in northern Madagascar (Nicoll and Langrand, 1989). This multi-protected area project includes ecosystem preservation, rural development based on sustainable use of natural resources, environmental education and ecotourism (Stuart *et al.*, 1990). Funds are being provided by USAID and the World Wide Fund for Nature; the latter also being responsible for project implementation (Greve, 1991).

Mantady National Park and Analamazaotra Special Reserve

The creation of the 10,000 ha Mantady National Park to augment the 810 ha Analamazaotra Special Reserve at Perinet (= Andasibe) has significantly increased the amount of protected forest for at least 10 lemur species, including *Daubentonia madagascariensis*, *Indri indri*, *Varecia variegata variegata*, *Propithecus d. diadema* and *Avahi l. laniger*.

The fauna and flora of the Analamazaotra Special Reserve are among the best studied in Madagascar (Nicoll and Langrand, 1989), and this research should be extended to the newly-protected forests of Mantady. A long-term ecological study of Mantady's indri population should be undertaken, and long-term monitoring of the Perinet indris, one of the country's major tourist attractions, should be carried out as well, as there has not been an in depth study of the indri since the early 1970s

(Pollock, 1975, 1977) and even that lasted just one year. Funding for the overall development and management of Mantady National Park is being provided by the World Bank and the United Nations Development Program, and is being managed by UNESCO under its Man and Biosphere Program (Greve, 1991).

Marotandrano and Tampoketsa-Analamaitso Special Reserves

At the present time, no information exists about the lemur fauna of the 42,200 ha Marotandrano Special Reserve or the 17,150 ha Tampoketsa-Analamaitso Special Reserve of northeastern Madagascar, nor about the status of the protected areas themselves, except that Tampoketsa-Analamaitso is said to have been heavily deforested (Nicoll and Langrand, 1989). However, given their location, it is reasonable to expect that these reserves harbor several lemur taxa of high conservation priority, possibly *Daubentonia madagascariensis*, *Indri indri*, *Propithecus diadema diadema*, and *Varecia variegata variegata*. It is recommended that surveys of the two reserves be conducted as soon as possible.

Midongy-Sud Classified Forest

The 67,568 ha Midongy-Sud Classified Forest of southeastern Madagascar is considered a critical site for conservation of biological diversity (Stuart *et al.*, 1990). Due to its large size, rugged terrain and relative inaccessibility, Midongy-Sud is presently well-protected. Conservation International is developing plans for management of Madagascar's system of Classified Forests, including Midongy-Sud (Greve, 1991). According to preliminary faunal surveys, *Daubentonia madagascariensis* and *Propithecus diadema edwardsi* are probably present in the forests of Midongy-Sud. Surveys of these and searches for other lemur taxa should commence as soon as possible.

Ambohijanahary Special Reserve

Despite their location in far western Madagascar, the forests of the 24,750 ha Ambohijanahary Special Reserve fall within the Central Domain and thus constitute a transition zone between the country's Eastern and Western Regions. Little is known about the lemur fauna of this reserve, except that *Propithecus verreauxi deckeni* is reported to be fairly common. A survey is needed to determine the status of this endangered subspecies and to search for other taxa of high conservation priority. It is also quite certain that this reserve requires better protection (Stuart *et al.*, 1990).

Sambirano Domain

Manongarivo Special Reserve

The 35,250 ha of the Manongarivo Special Reserve are covered by forests of the Sambirano Domain, harbor a large number of endemic plants and animals, and are home to at least eight lemur species, including *Daubentonia madagascariensis*, *Phanerfurfifer*, and probably *Haplemur griseus occidentalis*. Other than an expedition to Manongarivo in 1987 sponsored by the Madagascar Environmental Research Group, no detailed surveys of lemur populations have been conducted (Nicoll and Langrand, 1989). A well-defined system of trails within the reserve should facilitate study of resident lemur populations.

High Mountain Domain

Andringitra Nature Reserve and Pic d'Ivohibe Special Reserve

The 31,160 ha Andringitra Nature Reserve contains forests of the Eastern (1,600 ha), Central (21,860 ha) and High Mountain Domains (7,700 ha). The 3,450 ha Pic d'Ivohibe Special Reserve, which is located very close to Andringitra, lies entirely within the High Mountain Domain. Seven lemur species are reported from the Andringitra Nature Reserve, including the threatened *Lemur catta*, *Varecia variegata variegata* and *Avahi l. laniger*. Only two species are reported from Pic d'Ivohibe, but one, *Propithecus diadema edwardsi*, is a high conservation priority.

Due to the close proximity of these reserves, lemur surveys can be undertaken as a common project, although surveys of the larger, more inaccessible Andringitra Nature Reserve will require more time.

Plans for development and management of these reserves are part of a larger program administered by the World Wide Fund for Nature, which also includes support for the Marojejy Nature Reserve and Anjanaharibe-Sud Special Reserve. Funding for their development is being provided by the German Financial Cooperation (Greve, 1991).

Tsaratana Nature Reserve

The 48,622 ha Tsaratana Nature Reserve contains forests of the Eastern (8,270), Central (36,952) and High Mountain Domains (3,400), and is reported to harbor populations of seven lemur species, including *Phanerfurfifer parienti*. Land in this region is cultivated primarily for the production of coffee, vanilla, rice, beans, manioc and banana. Little information exists concerning the status of Tsaratana or its wildlife. Faunal and floral inventories are based largely upon an ORSTOM expedition that took place in 1966. Access to the reserve is somewhat limited and there are no facilities for researchers or visitors (Nicoll and Langrand, 1989). Basic surveys are needed to confirm the presence of the fork-marked dwarf lemur (*P. f. parienti*) and the possibility that other priority taxa inhabit Tsaratana.

Western Region

Western Domain

Tsingy de Bemaraha Nature Reserve and Tsimembo Classified Forest

At 152,000 ha, the Tsingy de Bemaraha Nature Reserve is one of the largest protected areas in Madagascar. It is located just east of the Tsimembo Classified Forest, estimated at 125,000 ha, another very significant forest tract. Each area is reported to contain eight lemur species. *Propithecus verreauxi deckeni* and *Phanerfurfifer* are common to both. In addition, *Mirza coquereli*, *Avahi laniger occidentalis* and *Daubentonia madagascariensis* are reported from Tsingy de Bemaraha. Aside from faunal inventories, the lemur communities of these areas remain largely unstudied.

Threats to both Tsingy de Bemaraha and Tsimembo include fire, logging and hunting. In addition, both are under-staffed

and under-equipped, and there are no facilities for management (Nicoll and Langrand, 1989).

Surveys are needed to determine the status of resident lemur populations. Due to the large size and relative inaccessibility of both Tsingy de Bemaraha and Tsimembo, it is likely that surveys will require several years to complete. Local public awareness campaigns would also be very useful. Funding for development and management of the Tsingy de Bemaraha Nature Reserve is being provided by the German Ministry of Economic Cooperation (BMZ: Bundesministerium für Wirtschaftliche Zusammenarbeit). UNESCO is responsible for implementation of this program (Greve, 1991).

Ankarafantsika Nature Reserve

The 60,250 ha Ankarafantsika Nature Reserve is located in close proximity to the 20,000 ha Ampijoroa Classified Forest. Preliminary studies of primate populations have been undertaken at Ankarafantsika (Tattersall and Sussman, 1975; Harrington, 1978; Albignac, 1981; Martin, 1982; Andriatsarafara, 1988). Of the seven lemur species present, three are considered conservation priorities, *Eulemur mongoz*, *Propithecus verreauxi coquereli* and *Avahi laniger occidentalis*. Threats to the two protected areas from the encroaching human population include traditional burning to create pasture for livestock, the introduction of feral cattle, charcoal production and poaching. The current staff at Ankarafantsika is too small and under-equipped to patrol the reserve effectively. A forestry field station does exist, however, within the Ampijoroa Classified Forest (Nicoll and Langrand, 1989).

Surveys are needed to determine the status of lemur populations throughout Ankarafantsika and Ampijoroa. Reserve guards need better transportation, a fire control program should be initiated, a public awareness campaign begun in surrounding communities and a forestry management program developed that provides for reforestation of areas where timber is used for construction and fuel (Nicoll and Langrand, 1989). Funding for the development of the Ankarafantsika Nature Reserve is being provided by the World Bank and the United Nations Development Program. The implementing agency is UNESCO under its Man and Biosphere Program (Stuart *et al.*, 1990; Greve, 1991).

Analamera and Ankarana Special Reserves

The 34,700 ha Analamera Special Reserve, although situated along Madagascar's northeast coast, falls within the Western Domain and represents a transition zone between Madagascar's two major phylogeographic regions. Less than 50 km southwest lies the 18,200 ha Ankarana Special Reserve which is floristically very similar.

Of the 11 lemur species reported from Ankarana and seven from Analamera, four shared taxa are conservation priorities: *Daubentonia madagascariensis*, *Propithecus diadema perrieri*, *Phanerfurfifer electromontis* and *Eulemur coronatus*. One other, *Avahi laniger occidentalis*, is reported from Ankarana. Analamera is an especially important reserve for *Propithecus diadema perrieri*, one of the rarest subspecies of diademed sifaka. Recent surveys estimate a population as high as 2,000 (Meyers and Ratsirarson, 1989). A second population of *Propithecus diadema perrieri* is reported from the northeastern

portion of the Ankarana Special Reserve, but densities are apparently lower than in Analamera (Hawkins *et al.*, in press).

The principal threat to Analamera is burning by local people to clear land for livestock pasture; cattle herds roam through parts of the reserve. It is not clear how seriously lemur populations are affected by hunting. Nicoll and Langrand (1989) maintain that they are not regularly hunted while Fowler *et al.* (1989) report otherwise. The reserve is currently understaffed, with only a single guard. There is no field station and available transportation is inadequate. Human encroachment also threatens the Ankarana Special Reserve. Several illegal settlements exist within the reserve, and fire to clear pasture for livestock, charcoal production and illegal logging are commonplace along its perimeter (Nicoll and Langrand, 1989). Hunting is described as limited; Fowler *et al.* (1989) suggests that lemur hunting is taboo in the Ankarana region. Problems of understaffing and inadequate equipment and facilities are similar to those of Analamera.

Based upon the surveys undertaken to date, long-term ecological studies are needed for *Propithecus diadema perrieri* in both reserves, as are further surveys to determine the status of *Daubentonia madagascariensis*. In addition, it has been suggested that *Haplemur simus* might be rediscovered at Ankarana (Harcourt and Thornback, 1990), so searches for it are recommended. The recommendation has also been made to create a forest corridor between Ankarana and Analamera. Development and management of the Analamera and Ankarana Special Reserves is being financed by USAID and the World Wide Fund for Nature (WWF), as part of a WWF-administered program that includes the Montagne D'Ambre National Park and the Foret D'Ambre Special Reserve.

Namoroka Nature Reserve and the Lac Kinkony Classified Forest

On the northwest coast of Madagascar lie two protected areas of importance to lemur conservation, the 21,742 ha Namoroka Nature Reserve and the classified forest of Lac Kinkony (10,000-15,000 ha). Namoroka is reported to harbor four species of lemurs and the forests of Kinkony two species. *Propithecus verreauxi deckeni* is common to both.

The chief threat to Namoroka is the annual burning to create pasture for livestock and to clear land for the planting of rice, manioc, banana and sugar cane. Fortunately, this region is sparsely populated and the resulting damage to the reserve is probably not severe. *Propithecus verreauxi deckeni* is reported to be common in the region due to its protection from hunting by a local taboo (Nicoll and Langrand, 1989).

Surveys are needed to determine the status of *Propithecus verreauxi* and the overall condition of these two protected areas. A study should also be conducted on the genetics of the sifakas inhabiting this region to clarify the taxonomy of *P. v. deckeni* and *P. v. coronatus*.

Zombitse and Vohibasia Classified Forests

The 21,500 ha Zombitse and Vohibasia Classified Forests are home to six species of lemurs including *Phaner furcifer pallescens*. They are reported to be severely threatened by fires from annual burning to create pasture, illegal logging for charcoal production and construction, cultivation of corn and hunt-

ing of lemurs and other wildlife. No formal studies have been conducted of the flora and fauna. There are no facilities within the boundaries of these areas, and the guards have inadequate equipment and transportation (Nicoll and Langrand, 1989).

Surveys of lemur populations are necessary. Field stations should be constructed and guard staffs properly equipped to patrol the two forests. A local public awareness program is also needed. The World Wide Fund for Nature is starting the implementation of a conservation/development project that plans to promote Zombitse and Vohibasia forests as a national park. This project is funded by Norwegian Aid (NORAD) (Greve, 1991).

Bemarivo, Maningozo and Kasijy Special Reserves

The 11,570 ha Bemarivo Special Reserve and 7,900 ha Maningozo Special Reserve are located about 50 km from one another on the west coast of Madagascar. The 18,800 ha Kasijy Special Reserve is several hundred kilometers inland due east. Virtually nothing is known about the status of these reserves nor of their lemur communities.

Based upon their presumed distributions, *Propithecus verreauxi deckeni* (and/or *P. v. coronatus*) and *Phaner furcifer pallescens* may occur in one or more of these special reserves. Searches are needed to determine the status of these two taxa and the general condition of these protected areas. Survey work should be relatively easy in Bemarivo and Maningozo due to easy access from nearby villages and secondary roads. Access to Kasijy, however, is only by river from distant villages, and surveys will be much more difficult. Genetic research on the sifakas is also necessary to clarify the taxonomy of *P. v. deckeni* and *P. v. coronatus*.

Andranomena Special Reserve, Analabe Private Reserve and the Kirindy Classified Forest

The 6,420 ha Andranomena Special Reserve, the 2,000 — 12,000 ha Analabe Private Reserve and the 100,000 ha Kirindy Classified Forest are located adjacent to one another in a region of western Madagascar believed to be an important center of species endemism. Based upon available faunal surveys, they share seven lemur species, including two considered to be conservation priorities: *Mirza coquereli* and *Phaner furcifer pallescens*.

Threats to Andranomena include illegal logging and hunting. The single guard is ill-equipped to protect Andranomena, especially as he is based far from the reserve. The Analabe Private Reserve, owned by Mr. Jean de Heaulme, is severely threatened by annual burning and poaching of wildlife, including lemurs. There is apparently no guard staff. In principle, the forestry concession at Kirindy is managed to provide renewable forest resources for the region. However, the concession suffers from illegal logging, cultivation and hunting within its boundaries (Nicoll and Langrand, 1989). Surveys are needed in all areas to determine the effects of exploitation on lemur populations. There is a great potential for ecotourism at Analabe.

Plans for the development and management of these areas are being prepared under the auspices of the Swiss Cooperation (DDA: Direction de la Cooperation Suisse au Developpement et a l'Aide Humanitaire).

Isalo National Park

The Isalo National Park is one of Madagascar's largest protected areas. However, the Central Domain forest of Madagascar's Eastern Region covers only 10% of the reserve's 81,540 ha (Nicoll and Langrand, 1989) and *Lemur catta* is the only priority lemur species found within its boundaries. Uncontrolled burning, cattle grazing and logging by local inhabitants represent the greatest threats to Isalo's remaining forests. While hunting of *Lemur fulvus* is reported, it is not clear whether this practice extends to *Lemur catta* as well. There is no permanent field station and very little scientific research has taken place here.

Nicoll and Langrand (1989) recommend the creation of two forestry posts or field stations within Isalo, a clearly marked perimeter and a public awareness campaign in the surrounding vicinity. A census of ring-tailed lemur population is also needed.

Southern Domain

Tsimanampetsotsa Nature Reserve

The 43,200 ha Tsimanampetsotsa Nature Reserve represents the largest protected area of Southern Domain dry forest in Madagascar's Western Region, and apparently an important tract for the survival of *Lemur catta*. The principal threats to Tsimanampetsotsa are the conversion of forests to pasture and the collection of wood by local people for home construction. No scientific studies have been conducted here, there are no permanent research facilities available and the forest guard must reside a considerable distance from the reserve.

A field station should be constructed within the boundaries of Tsimanampetsotsa, and training and adequate transportation provided for the guard staff. Surveys and censuses are also necessary to determine the size and status of *Lemur catta* populations in the reserve.

Bora Special Reserve

The 8,380 ha Bora Special Reserve is a relatively isolated protected area in northwestern Madagascar. Two lemur species are reported from its dry forests, *Eulemur f. fulvus* and *Propithecus verreauxi coquereli*, but the sifaka's existence there is not confirmed.

The reserve is divided into two parcels, both of which are exploited by the local people and commercial concerns. Fires are set to clear land for agriculture and pasture, timber is taken for construction and fuelwood, and lemurs (at least *E. fulvus*) are hunted for food (Nicoll and Langrand, 1989). No studies have been conducted in this area and there are currently no facilities to accommodate researchers or other visitors.

Surveys are needed to confirm the presence of *Propithecus verreauxi coquereli* and to assess the status of the entire reserve. Better protection could be achieved by establishing a field station on site from which regular patrols can be conducted.

Beza-Mahafaly Special Reserve

Despite its small size (580 ha) and the fact that of its five resident lemur species, only one, *Lemur catta*, is included in our list of priorities, the Beza-Mahafaly Special Reserve remains an important site for lemur conservation in Madagascar. A well-established field research program continues to provide information on the behavior and ecology of lemur communities which is essential to designing and managing protected areas and tourism in Madagascar's western and southern forests (Rakotomanga *et al.*, 1987; Richard *et al.*, 1987).

Support for Beza-Mahafaly has been provided over the past 15 years by the World Wildlife Fund-U.S. and USAID (Nicoll and Langrand, 1989). Long-term field research of lemur communities should continue at this site.

Berenty Private Reserve

The Berenty Private Reserve is owned by the de Heaulme family, and its situation with regard to lemur conservation is similar to that at Beza-Mahafaly. Six lemur species are present here (*Lemur catta* is a priority and their populations have been the subject of scientific research for more than three decades. In addition, Berenty is the reserve most visited by Malagasy and foreign tourists interested in lemurs and other wildlife. Thus it remains an important site for research on the management of small populations of lemurs and the benefits and drawbacks of ecotourism.

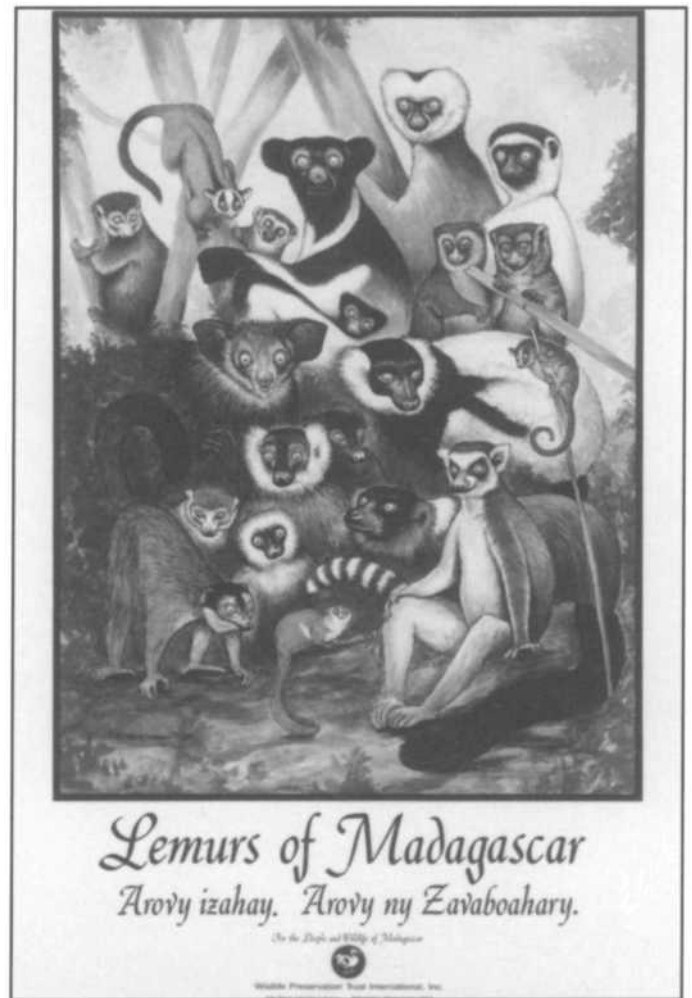
Wildlife Preservation Trust International (WPTI) is supporting a research project to assess the status of Berenty's forests and lemur populations and to develop management techniques to prevent degradation of this small protected area. Support for this research should continue.

Public Awareness Campaigns

A series of public awareness campaigns are recommended nationwide, focusing primarily on the lemur taxa of the higher conservation priority categories: aye-aye, hairy-eared dwarf lemur, Coquerel's dwarf lemur, fork-marked dwarf lemur, black-and-white and red ruffed lemurs, ring-tailed lemur, Sclater's lemur, golden bamboo lemur, greater bamboo lemur, Lac Alaotra gentle lemur, indri, diademed sifaka, silky sifaka, Milne-Edwards' sifaka, Perrier's sifaka, Tattersall's sifaka, crowned sifaka, Coquerel's sifaka and Decken's sifaka. These taxa serve as "flagship" species and subspecies for wildlife conservation efforts throughout Madagascar, and can help focus public attention on the need to incorporate more sound environmental practices in their daily lives.

Materials to be included in such campaigns include educational poster, t-shirts, stickers and pamphlets (see examples on this page). Designs should differ from one region to another, customized to reflect associations between species and the need to protect populations within existing protected areas, as well as to create new parks and reserves. Production and distribution of lemur-oriented educational materials should be conducted in conjunction with existing community outreach programs, or used to stimulate such programs in new areas.

The total production costs of public awareness materials over the time frame of this Action Plan is estimated at \$200,000.

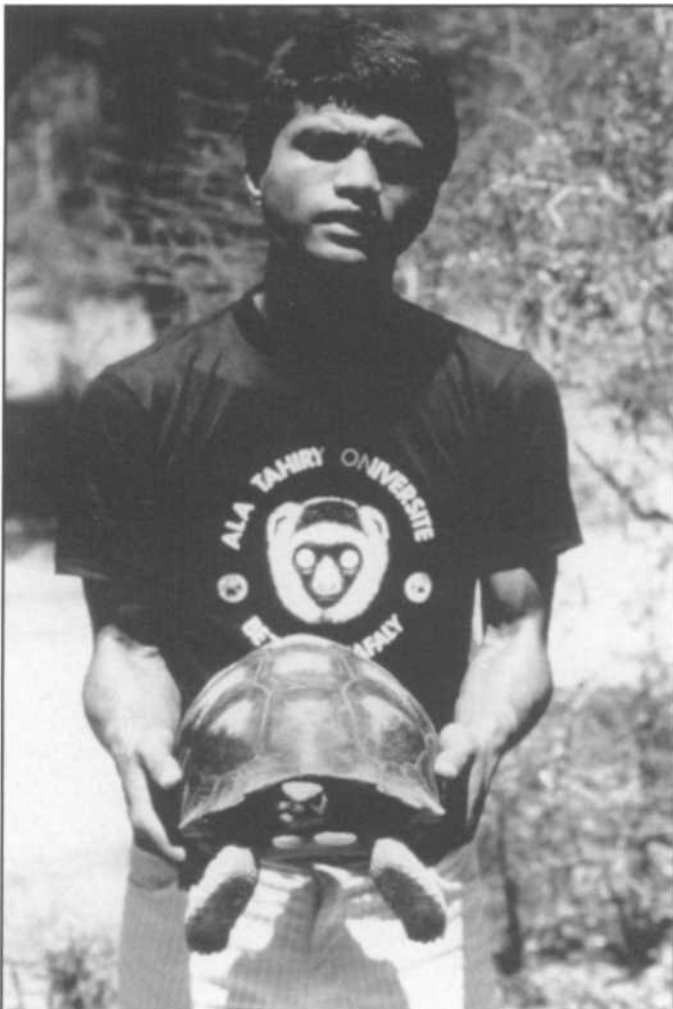


"Lemurs of Madagascar" poster - designed by Stephen Nash and produced by Wildlife Preservation Trust International for distribution throughout Madagascar.



(Above) A poster focusing on the need to protect *Haplemur griseus alaotrensis* and other wildlife of La Alaotra's wetland habitats. Artwork by William Oliver. Produced by the Jersey Wildlife Preservation Trust.

(Left) A Malagasy biology student holds a rare radiated tortoise and sports a t-shirt designed to increase awareness of the Beza-Mahafaly Special Reserve. The t-shirt depicts Verreaux's sifaka.



Russell A. Mittermeier

NY INDRIIDES ETO MADAGASIKARA LES INDRIIDES DE MADAGASCAR

Ny gito da mitana an'ny tsena hita eo amin'ny harena nanaivany eto Madagasikara. Tsy hita na aiza na aiza eran'izao tontolo izao afa-tsy eto ihany izy ireo.
29 no isan'ny karazana fantatra hita amin'izao any amin'izany ny karazana 5 avy amin'ny Indriidae. Izy ireo no lehibe sy mahavariana indrindra amin'ny karazana-gito. Mita ho lany tsarankia izy ireo noho ny fihazana sy ny fandrila ary ny fahaleovonan'ny ala izay fomenany tany am-piandrianana.
Ampio isahy hana azy ireo.

Les lemuriens constituent une part importante du patrimoine naturel de Madagascar. Ils sont uniques et ne se rencontrent nulle part ailleurs au monde.
29 espèces sont reconnues à ce jour parmi lesquelles 5 espèces d'Indriidae. Elles constituent les plus grandes et les plus spectaculaires espèces de lemuriens. Elles sont menacées de disparition à cause de la chasse et du piégeage dont elles sont l'objet et par la destruction de la forêt naturelle qui constitue leur habitat originel.
Aidez-nous à les protéger.

13. Tsiarahaka, Sifaka, Ankombe malandy
Propithecus verreauxi coquereli

11. Tsiarahaka, Sifaka
Propithecus coquereli
Propithecus verreauxi coquereli

10. Fotaka, Tsarahangira
Awaia leakea
Awaia leakea saccidulata

9. Sifaka
Propithecus verreauxi
Propithecus verreauxi verreauxi

8. Sifaka
Propithecus verreauxi (forme malainque)
Propithecus verreauxi verreauxi

7. Sifaka
Propithecus verreauxi
Propithecus verreauxi verreauxi

6. Sifaka
Propithecus verreauxi
Propithecus verreauxi verreauxi

12. Tsiarahaka, Sifaka
Propithecus de Meillon
Propithecus verreauxi de Meillon

1. Babakoto
Indri
Indri indri

3. Propithecus de Tattersall
Propithecus tattersalli

2. Rajako, Ankombe jiro
Propithecus de Parry
Propithecus gladiata parryi

4. Sifaka, Sifaka
Propithecus gladiata
Propithecus gladiata gladiata

5. Fotaka, Ampangy, Awaia
Awaia leakea
Awaia leakea leakea



Drawn and designed by Stephen D. Nash. ©1989 Stephen D. Nash

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Genetic Research

The taxonomy of certain lemur taxa requires further investigation. Field research that will contribute to such studies has been included in the the previous section under protected area surveys. However, supplemental funding will be required for additional specialized field procedures (e.g. capture of animals, blood collection, storage and transport, etc.) and laboratory analyses.

It is recommended that the following taxonomic questions be investigated using the most up-to-date laboratory techniques.

1. Are *Propithecus diadema holomelas* and *P. d. edwardsi* distinct subspecies?
2. Are *Propithecus verreauxi coronatus* and *P. v. deckeni* distinct subspecies?
3. Does *Varecia variegata variegata* consist of two, three or more distinct subspecies?
4. Are *Eulemur fulvus albocollaris* and *E. f. collaris* distinct from other subspecies of *E. fulvus* at the species level?
5. Are subspecific designations appropriate within *Phaner furcifer*?
6. Do undescribed subspecies of *Eulemur rubriventer* exist? (*)
7. Do undescribed subspecies of *Microcebus rufus* exist? (*)
8. Are *Eulemur fulvus mayottensis* and *E. f. fulvus* synonymous?

Based upon a cost of approximately \$10,000-\$15,000 per project, we recommend that a total of \$100,000 be allocated over the next three years for genetic research projects to answer these questions about lemur taxonomy.

- (*) Even though these species are not considered conservation priorities under the rating system employed for this document, further research could potentially identify subspecies of greater conservation concern.

Professional Training

In-country training of Malagasy primatologists is essential to lemur conservation. At present, Madagascar has very few trained primatologists of its own. There is a need to include a primatology course in the curriculum of the Wildlife Management Training Program currently being developed by Conservation International in collaboration with the University of Madagascar. Given the importance of Madagascar's primate fauna to the country as a whole, this program should be considered a high educational priority.

The approximate cost of a primate course for this program would be \$100,000 over the next seven years.

Captive Breeding

In 1985 and 1987, two very significant meetings were held on St. Catherine's Island, Georgia to address the subject of lemur conservation, and the establishment of captive breeding programs was a major topic for discussion at both. Subsequently, in May 1991, representatives of the IUCN/SSC Captive

Breeding Specialist Group and the Primate Specialist Group met to develop a Global Captive Action Plan for Primates. Based on the recommendations resulting from these three meetings, captive breeding programs have been proposed for the following taxa (threat status in this list is based on the CBSG/PSG plan and differs slightly from that proposed in this document):

Critical

Daubentonia madagascariensis
Allocebus trichotis
Propithecus verreauxi coronatus
Propithecus tattersalli
Eulemur macaco flavifrons
Hapalemur griseus alaotrensis
Hapalemur simus
Hapalemur aureus

Endangered

Propithecus diadema candidus
Propithecus diadema perrieri
Eulemur coronatus
Eulemur mongoz
Varecia variegata rubra
Varecia variegata variegata

Vulnerable

Propithecus diadema diadema
Propithecus diadema edwardsi
Propithecus verreauxi coquereli
Propithecus verreauxi deckeni
Eulemur fulvus albocollaris
Eulemur fulvus collaris *
Eulemur fulvus sanfordi *
Eulemur macaco macaco *
Eulemur rubriventer *

Taxa marked with an asterisk (*) are not considered priorities in this Action Plan.

As a result of the landmark meetings held on St. Catherine's Island, a consortium known as the Madagascar Fauna Group (MFG) was formed by zoological parks and captive breeding centers in the United States and Europe. MFG member institutions are committed to preserving endangered lemurs and other Madagascar wildlife through support of in-situ and ex-situ captive breeding efforts, and to providing technical advice and training to Malagasy institutions and biologists. Thus far, the MFG has placed a technical advisor at Madagascar's national zoo, Parc Tsimbazaza, and helped to establish Zoo Ivoloina in cooperation with the Duke University Primate Center and Wildlife Preservation Trust International.

In addition to developing captive breeding programs at the Duke Primate Center, Jersey Wildlife Preservation Trust, the Mulhouse and Vincennes Zoo in France and other selected facilities outside Madagascar, there is an urgent need to develop greater captive breeding capacity within Madagascar itself. However, we do not include cost estimates for captive breeding efforts in this Action Plan since they will be covered in other documents.

Lemur Conservation Budget: 1993-1999

Creation of New Protected Areas

Area	Priority Taxa	Surveys	Field Station(s) ¹	Long-Term Studies ¹
Masoala Peninsula	<i>Varecia variegata rubra</i> <i>Daubentonia madagascariensis</i> <i>Phaner f. furcifer</i> <i>Avahi l. laniger</i>	\$15,000	\$110,000	\$70,000
Maroantsetra	<i>Varecia variegata rubra</i> <i>Varecia variegata variegata</i> <i>Daubentonia madagascariensis</i> <i>Phaner f. furcifer</i> <i>Avahi l. laniger</i>	\$15,000	\$110,000	\$70,000
Daraina	<i>Propithecus tattersalli</i> <i>Daubentonia madagascariensis</i> <i>Phaner furcifer</i>	\$10,000	\$110,000	\$70,000
Lac Alaotra	<i>Haplemur griseus alaotrensis</i>	\$10,000	\$110,000	\$70,000
Subtotals		\$50,000	\$440,000	\$280,000

Conservation Programs Associated With Existing Protected Areas

Protected Area	Priority Taxa	Surveys	Field Station(s) ¹	Long-Term Studies ¹
<u>Highest Priority (1993-1999)¹</u>				
Mananara-Nord Biosphere Reserve (Vezanantsoro and Nosy Atafana National Parks)	<i>Allocebus trichotis</i> <i>Daubentonia madagascariensis</i> <i>Indri indri</i> <i>Propithecus d. diadema</i> <i>Varecia v. variegata</i>	\$15,000	\$110,000	\$70,000
Ranomafana National Park	<i>Haplemur aureus</i> <i>Haplemur simus</i> <i>Daubentonia madagascariensis</i> <i>Propithecus diadema edwardsi</i> <i>Varecia variegata variegata</i> <i>Avahi l. laniger</i>	—	Station Present; Maintenance \$70,000	\$70,000
Zahamena Nature Reserve	<i>Daubentonia madagascariensis</i> <i>Indri indri</i> <i>Propithecus d. diadema</i> <i>Varecia variegata variegata</i> <i>Phaner f. furcifer</i> <i>Avahi l. laniger</i>	\$15,000	\$110,000	\$70,000
Mantady National Park	<i>Daubentonia madagascariensis</i> <i>Indri indri</i> <i>Propithecus d. diadema</i> <i>Varecia variegata variegata</i> <i>Avahi l. laniger</i>	\$15,000	\$110,000	\$70,000
Ambatovaky Special Reserve	<i>Allocebus trichotis</i> <i>Daubentonia madagascariensis</i> <i>Indri indri</i> <i>Propithecus d. diadema</i> <i>Varecia variegata variegata</i> <i>Phaner f. furcifer</i>	\$15,000	\$110,000	\$70,000

Protected Area	Priority Taxa	Surveys	Field Station(s) ¹	Long-Term Studies ¹
<u>Highest Priority (1993-1999)</u>				
Manongarivo Special Reserve	<i>Daubentonia madagascariensis</i> <i>Phaner furcifer pallescens</i> <i>Hapalemur griseus occidentalis</i> (?)	\$15,000	\$110,000	\$70,000
Marotandrano and Tampoketsa-Anamalaitso Special Reserves	<i>Daubentonia madagascariensis</i> <i>Indri indri</i> <i>Propithecus d. diadema</i> <i>Varecia variegata variegata</i>	\$15,000	\$220,000 (two needed)	\$70,000
Anjanaharibe-Sud and Marojejy Special Reserves	<i>Daubentonia madagascariensis</i> <i>Indri indri</i> <i>Propithecus diadema candidus</i> <i>Avahi l. laniger</i>	\$15,000	\$220,000 (two needed)	\$70,000
Montagne d'Ambre National Park and Foret d'Ambre Special Reserve	<i>Daubentonia madagascariensis</i> <i>Phaner furcifer electromontis</i> <i>Eulemur coronatus</i>	\$15,000	\$110,000	\$70,000
Analamera and Ankarana Special Reserves	<i>Daubentonia madagascariensis</i> <i>Propithecus diadema perrieri</i> <i>Eulemur coronatus</i> <i>Avahi laniger occidentalis</i> <i>Hapalemur griseus occidentalis</i> (?)	\$15,000	\$220,000 (two needed)	\$70,000
Andohahela Nature Reserve	<i>Daubentonia madagascariensis</i> <i>Propithecus diadema edwardsi</i> <i>Phaner f. furcifer</i> (?) <i>Avahi l. laniger</i> <i>Lemur catta</i>	\$15,000	\$110,000	\$70,000
Namoroka Nature Reserve and Lac Kinkony Classified Forest	<i>Propithecus verreauxi coronatus</i> or <i>P. v. deckeni</i>	\$15,000	\$220,000 (two needed)	\$70,000
		\$165,000	\$1,720,000	\$840,000

High Priority (1994-1999)²

Midongy-Sud Classified Forest	<i>Daubentonia madagascariensis</i> <i>Propithecus diadema edwardsi</i>	\$15,000	\$100,000	\$60,000
Tsingy de Bemaraha Nature Reserve and Tsimembo Classified Forest	<i>Mirza coquereli</i> <i>Propithecus verreauxi deckeni</i> <i>Phaner furcifer pallescens</i> <i>Avahi laniger occidentalis</i> <i>Hapalemur griseus occidentalis</i>	\$20,000	\$200,000 (two needed)	\$60,000
Ankarafantsika Nature Reserve	<i>Propithecus verreauxi coquereli</i> <i>Eulemur mongoz</i> <i>Avahi laniger occidentalis</i>	\$15,000	Station Present; Maintenance \$70,000	\$70,000 (Studies in Progress)
Ambohijanahary Special Reserve	<i>Propithecus verreauxi deckeni</i>	\$15,000	\$100,000	\$60,000
Bemarivo, Maningozo and Kasijy Special Reserves	<i>Propithecus verreauxi deckeni</i> (?) <i>Phaner furcifer pallescens</i>	\$20,000	\$300,000 (three needed)	\$60,000

Protected Area	Priority Taxa	Surveys	Field Station(s) ²	Long-Term Studies ²
<u>High Priority (1994-1999)²</u>				
Andranomena Special Reserve, Analabe Private Reserve and Kirindy Forest	<i>Mirza coquereli</i> <i>Phaner furcifer pallescens</i>	\$15,000	\$300,000 (three needed)	\$60,000
Andringitra Nature Reserve and Pic d'Ivohibe Special Reserve	<i>Varecia variegata variegata</i> <i>Propithecus diadema edwardsi</i> <i>Avahi l. laniger</i> <i>Lemur catta</i>	\$15,000	\$200,000 (two needed)	\$60,000
Betampona Nature Reserve and Mangerivola Special Reserve	<i>Daubentonia madagascariensis</i> <i>Indri indri</i> <i>Varecia variegata variegata</i> <i>Phanerf. furcifer (?)</i> <i>Avahi l. laniger</i>	\$15,000	\$200,000 (two needed)	\$60,000
Nosy Mangabe Special Reserve	<i>Daubentonia madagascariensis</i> <i>Varecia v. variegata</i>		Station Present Maintenance \$70,000	\$70,000 (Studies in Progress)
		\$130,000	\$1,540,000	\$560,000
<u>Priority (1995-1999)³</u>				
Manombo Special Reserve	<i>Eulemur fulvus albocollaris</i>	\$10,000	\$90,000	\$50,000
Tsaratanana Special Reserve	<i>Phaner furcifer parienti</i>	\$15,000	\$90,000	\$50,000
Bora Special Reserve	<i>Propithecus verreauxi coquereli</i>	\$10,000	\$90,000	\$50,000
Tsimanampetsotsa Nature Reserve				
Isalo National Park	<i>Lemur catta</i>	\$10,000	\$90,000	\$50,000
Beza-Mahafaly Special Reserve	<i>Lemur catta</i>		Station Present; Mainenance \$70,000	\$70,000 (Studies in Progress)
Berenty Private Reserve	<i>Lemur catta</i>		Station Present; Maintenance \$70,000	\$70,000 (Studies in Progress)
		\$45,000	\$500,000	\$340,000
Subtotals for Existing Protected Areas		\$340,000	\$3,760,000	\$1,740,000
Total Budget for New and Existing Protected Areas				
		\$390,000	\$4,100,000	\$2,040,000

¹ For the categories Creation of New Protected Areas and the Highest Priority category of Existing Protected Areas, we ideally assume that programs will commence in the first year of the Action Plan (1993). Following what is said of project costs on page 41, we recognize the following needs for Field Stations and Long-Term Studies:

Field Stations: \$50,000 construction costs in first year, plus \$10,000 per year for subsequent six years for a total of \$110,000 per station.

Long-Term Studies: \$10,000 per year for seven years, for a total of \$70,000 over the duration of the Action Plan.

² For the High Priority category of Existing Protected Areas, we ideally assume that programs will commence in the second year of the Action Plan (1994), and therefore recognize the following needs for Field Stations and Long-Term Studies:

Field Stations: \$50,000 construction costs in first year, plus \$10,000 per year for subsequent five years for a total of \$100,000 per station.

Long-Term Studies: \$10,000 per year for six years for a total of \$60,000 over the duration of the Action Plan.

³ For the Priority category of Existing Protected Areas, we ideally assume that programs will commence in the third year of the Action Plan (1995), and therefore recognize the following needs for Field Stations and Long-Term Studies:

Field Stations: \$50,000 construction costs in first year, plus \$10,000 per year for subsequent four years, for a total of \$90,000.

Long-Term Studies: \$10,000 per year over five years, for a total of \$50,000 over the duration of the Action Plan.

BUDGET SUMMARY

CREATION OF NEW PROTECTED AREAS \$770,000

CONSERVATION PROGRAMS FOR EXISTING PROTECTED AREAS

HIGHEST PRIORITY (1933-1999) \$2,725,000

HIGH PRIORITY (1994-1999) \$2,230,000

PRIORITY (1995-1999) \$885,000

PUBLIC AWARENESS CAMPAIGNS \$200,000

GENETIC RESEARCH \$100,000

PROFESSIONAL TRAINING \$100,000

TOTAL BUDGET (1993-1999) \$7,010,000

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